PROSPECTS FOR GROWING KNOWLEDGE-BASED INDUSTRIAL CLUSTERS IN ATLANTIC CANADA

FINAL REPORT
PART 2 - Six Cluster Profiles

PROSPECTS FOR GROWING KNOWLEDGE-BASED INDUSTRIAL CLUSTERS IN ATLANTIC CANADA

Part 2:
Six Cluster Profiles

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July 25, 1997

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I THE ATLANTIC CANADA INFORMATION HIGHWAY CLUSTER

1.0
HIGHLIGHTS

Atlantic Canada's Information Highway (IH) cluster offers a virtually complete spectrum of services. Existing markets and applications are already significant, and numerous emerging and future markets are apparent. Current value of the cluster's services output is estimated as being over $2 billion annually.

Potential growth opportunities and challenges to the cluster are to develop new and/or enhanced services whose software, management skills, systems integration and other elements could be exported outside the region. There does not seem to be any particular reason why this could not be done, although some issues still need to be resolved. The current cluster profile shows significant technological and service strengths.

There is a "first-tier" level of service providers that virtually cover the complete spectrum of services. These include:

- full-line telephone companies (telcos) offering service throughout the region based on leading-edge digital technology;
- cable operators reaching throughout the region;
- up-links to satellite communications, which guarantees global communications;
- cellular and wireless phone options;
- terrestrial microwave systems;
- internet service providers;
- alternative carriers providing competition as markets liberalize; and
- specialized communications systems available in Atlantic Canada, most notably marine/off-shore communications.

Backing the first-tier service providers is a second tier of IH infrastructure suppliers. Although Atlantic Canada does not itself develop and produce major hardware items, nevertheless, the local supply base and regional firms can provide virtually all leading-edge equipment, and does have a specialized "niche" hardware development capability. Infrastructure supply capabilities are not a limitation. These elements include:

- major telecommunications hardware from a global technology leader;
- an available wide range of electronic systems;
- wireless communications hardware;
- electronics/telecom component development;
- computer networks and switches;
- cable transmission hardware;
- couplers and other connectivity hardware; and
- computer memory circuits.

A third tier represents IH hardware and services development capabilities. These capabilities are wide-ranging. They include:

- systems integration;
- local-areas networks (LANs);
- wide-area networks (WANs);
- software engineering and custom software;
- multimedia;
- IH product development; and
- related market research and strategic planning.

There is an equally wide ranging fourth tier of co-operative and publicly-available research, featuring:

- networks development;
- market-specific service development;
- specialized systems;
- broadband research;
- partnership R&D;
- business and market research; and
- strategic forecasting and analysis.

Finally, there is an excellent network of related business support organizations and activities, including co-operative action by all levels of government.

Costs are not a limiting factor to the cluster. More than one study concluded that Atlantic Canada has a cost competitive advantage both in "head office" operations such as call center services, as well as in manufacturing.

The diversity of firms mitigates against cooperation, except at the level of nodes (e.g. multimedia) where there is more common interest.

Most innovative firms are small and lack the managerial and marketing expertise needed to grow (e.g. access financing) and to penetrate other markets.

Demand outstrips supply for IT professionals.

Issues in developing this cluster include:

- developing market research skills;
- deepening existing technical capabilities, including rural infrastructure;
- developing distribution networks for products; and
- deepening software engineering skills further.

Specific potential project developments for the cluster could be:

- using Atlantic Canada as a "most demanding customer" for new IH development, for example building on initiatives such as "Vista phones";
- extending the Telecommunications Applications Research Alliance (TARA) project to include further players, and/or developing parallel initiatives; and
- developing more "smart" venture capital capability to offset limitations on access to financing; problem may not be access to financing per se, rather, "smart" management "packages" that include marketing and other support.

Exhibit I-1 gives an overview of the Atlantic Canada Information Highway cluster.

Exhibit I-2 summarizes the current development status of the Information Highway status against the eight ingredients of success. While the cluster scores fairly high in most categories there remains significant problems related to the provision of skilled people, financing and entrepreneurship.

Exhibit I-1: Grappe de l inforoute au Canada atlantique

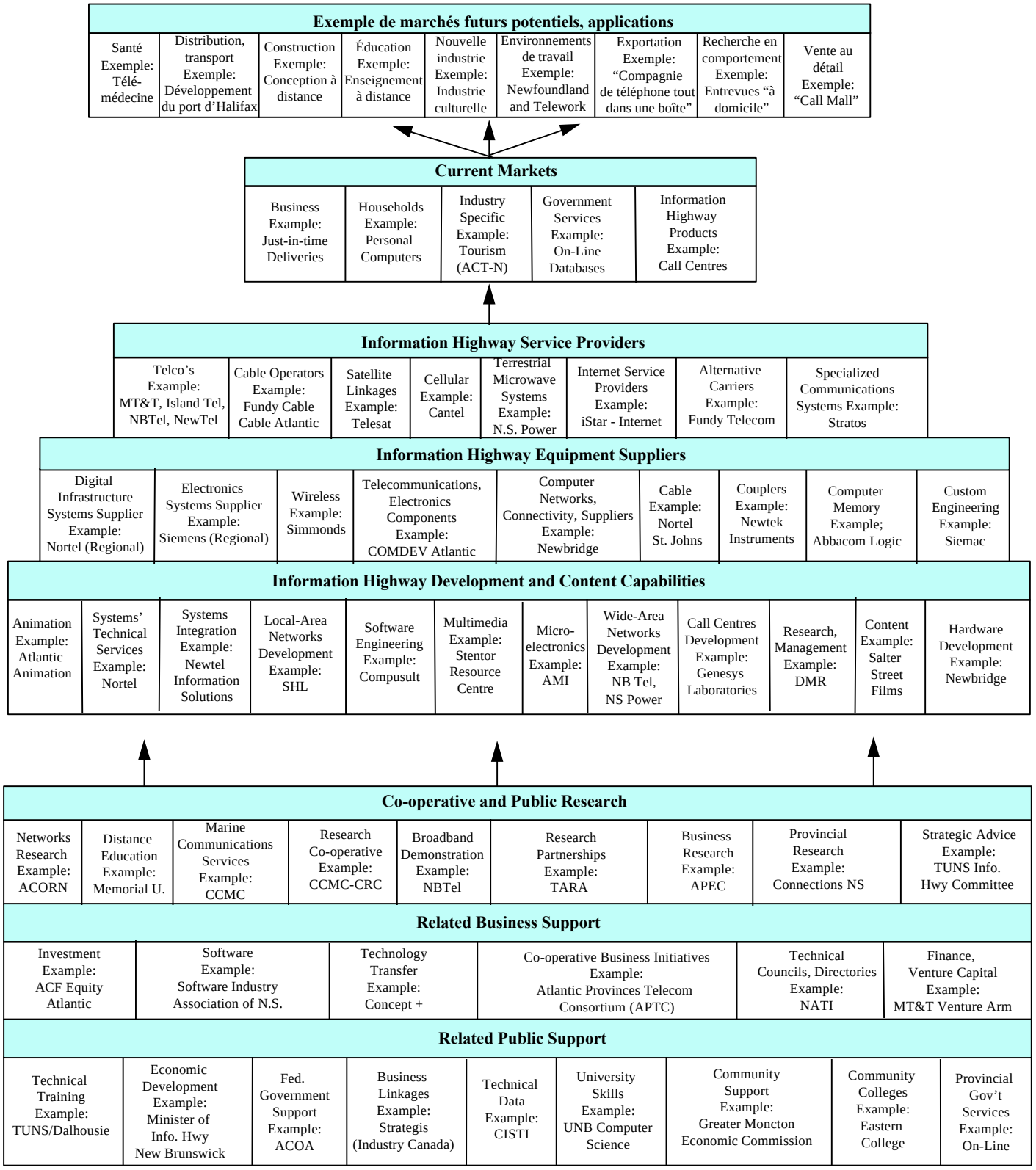
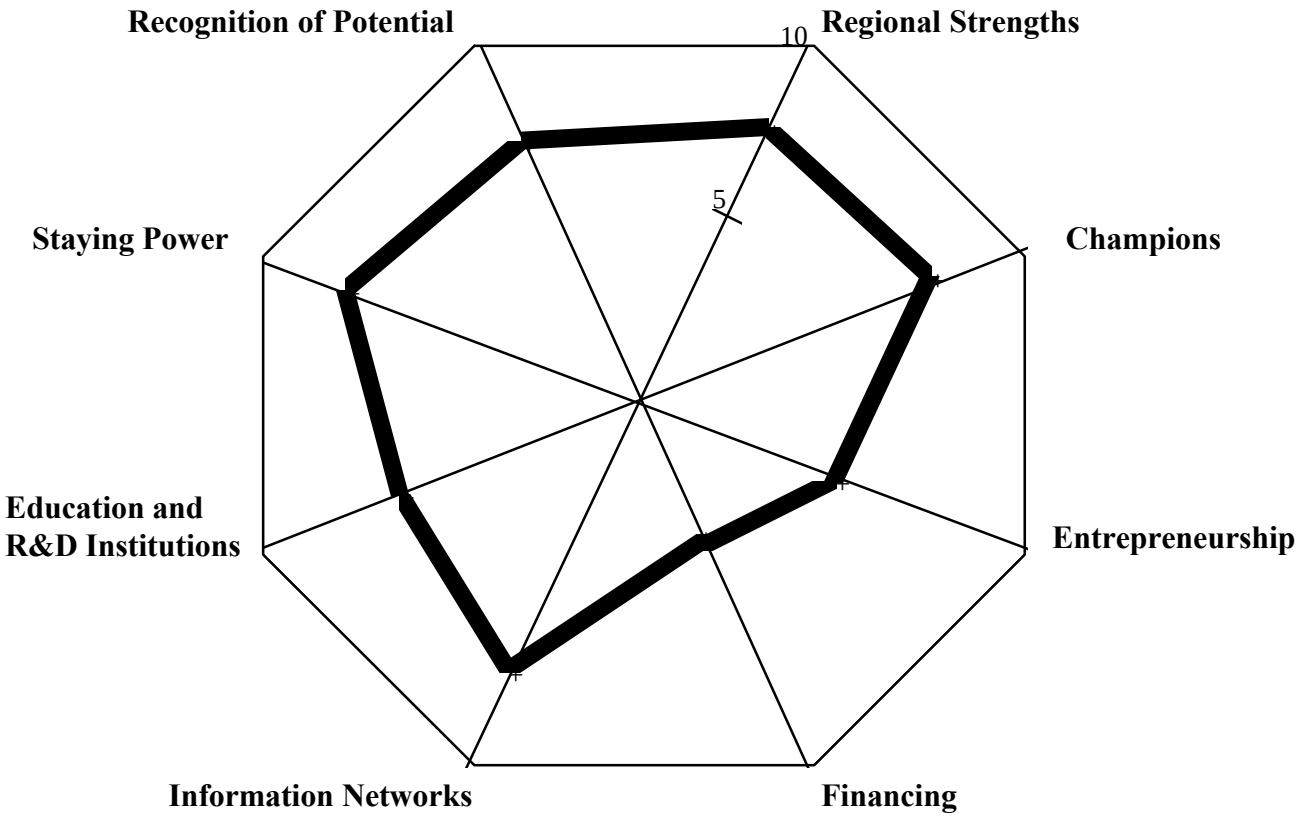


Exhibit I-2: Development Status of the Atlantic Canada Information Highway Cluster



2.0
CLUSTER PROFILE

2.1 CURRENT MARKETS, APPLICATIONS

Current Atlantic Canada markets for information highway services are substantial. They include:

Government Services

Atlantic Canada governments have taken a leading role in putting government services and information "on-line". Applications range from business intelligence to renewal of driver's licences. The region is endeavouring to capitalize on the information highway to enhance access and services from provincial governments.

Information Highway Products

Atlantic Canada has been renowned for developing IH products. A well known example is call center services. While Moncton, N.B., has probably received the most attention for its success in attracting this sort of investment, other locations in Atlantic Canada have also set up similar shops, most notably in PEI and in Saint John.

The success of the teleservices cluster in the region is based upon four important factors:

- excellent telecommunications infrastructure (e.g., NBTel was the first phone company in Canada to offer fully digital facilities);
- a bilingual, well-educated workforce;
- low costs with respect to all of North America; and
- a time-zone position that allows firms to service European and North American clients.

Industry-specific - Tourism

The promotion of tourism in Atlantic Canada has traditionally been handled by individual provinces. However, independent marketing strategies are changing thanks to the Atlantic Canada Tourism Partnership which brings together government, industry and ACOA representatives. There is now ACT-N, the IH networks linking tourism services and initiatives.

A Nova Scotia firm is working for the Partnership to offer centralized travel and information services to potential tourists through a single 1-800 number. Almost all of the businesses offering tourist accommodation in Nova Scotia have signed-up with the database and information service. Penetration in the other provinces is growing steadily.

Households

Households in Atlantic Canada hold their own in IH-related services. For example, about 33% of all households in the region own a personal computer. This is very comparable to the rest of North America. There is no particular limitation on "computer literacy" in the region.

Business

Businesses in Atlantic Canada already use the IH, an example being co-ordination of "just-in-time" delivery by suppliers to customers in manufacturing and processing. To illustrate, one of the largest Atlantic Canada bakeries, which provide various name-brand baked goods for numerous Atlantic Canada producers, relies on Internet access for (literally) hourly delivery requirements.

2.2 FUTURE MARKETS, APPLICATIONS

Emerging and future markets and applications, becoming notably apparent in the published literature and in several cases with explicit experimentation already underway in Atlantic Canada, include:

Health

Telemedicine is being investigated in Atlantic Canada, most notably by a distance diagnostics experiment service being conducted by Victoria General Hospital in Halifax.

Transportation

The Port of Halifax is likely to see a major expansion and renewal, based on its prime location on North America – Europe shipping lanes and also on new, enhanced Canadian rail links right into the mid-west U.S. Total throughput could treble over the next ten years. There will be immense opportunities for systems and software to support this flow, including manifests, trans-shipments, customs clearance, etc.

Retailing

NBTel has developed a shop-at-home phone system. The $40 million Call Mall venture is the first to be offered in the world.

Education

Memorial University is a leading member of the new Network of Centers of Excellence in "Telelearning", centered at Simon Fraser University in Burnaby, B.C., and supported by the federal government.

Niche areas in the cultural industries are a world-recognized strength in Atlantic Canada (e.g., content, humour). This is base for future development.

New Work Environments

The government of Newfoundland and Labrador has undertaken a deliberate "telecommuting" experiment by carrying work on the IH. While this concept is still in its infancy – only about 2% of the working population "telecommutes" in Canada – there are immense future prospects.

Exports

NBTel is already developing "turn-key" telco-in-a-box approaches to supplying complete telco capability to developing regions and other overseas markets. The approach involves "build, operate, transfer" concepts to areas that potentially can accept NBTel's level of services and organization.

Behavioural Research

A benefit of the relatively stable population of Atlantic Canada is that certain forms of social and human behavioural research can be carried out with better than average results. The IH conceivably allows faster "in-home" surveys and other techniques that can aid responsiveness of business and government to consumer needs. Moreover, the area's universities allow the development of the sophisticated techniques required to capitalize on virtually real-time survey and interviews.

2.3 VALUE OF TOTAL OUTPUT

This is a significant cluster from the standpoint of total value of output. Total output of services can be estimated as being over $2 billion annually. There are several hundred different firms in the cluster, ranging from software "boutiques" of 1-5 people to giant corporations like MT&T with 3,700 employees. Exhibit I-3 gives details.

Exhibit I-3
Value of Output of Services

SERVICE PROVIDERS	ESTIMATED VALUE OF SERVICES
Telcos (MT&T, NBTel, NewTel)	$ 1.5 billion
Cable Operators	150 million
Cellular and Alternative Carriers	150 million
Software Developers and Computer Service Providers	250 million
Specialized systems	10 million
Private systems	100 million
Estimated Total	**$2.16 billion**

Source: Atlantic Progress "The Top 101 Companies of Atlantic Canada", Sept. 1996; Atlantic Provinces Economic Council Information Technology in Atlantic Canada, Moncton 1995; Nordicity estimates.

Besides this total output, there is also already substantial employment in Atlantic Canada through the IH. For example, APEC has calculated that the Software Development and Computer Service Providers segment of this service base contained 2,252 employees in 1995. This may be one of the more labour-intensive segments of the cluster.

If scaled up relative to the total value of output, it would suggest about 20,000 people are involved in this cluster.

2.4 CURRENT STRENGTHS IN INFORMATION HIGHWAY SERVICE PROVIDERS

There are no technical limitations on the Atlantic Canada IH that prevent leading-edge services from being developed for global markets. The range and depth of technical capabilities of the Atlantic Canada IH service providers is impressive, as shown below.

2.4.1 Telephone Companies (Telcos)

The backbone of the IH is the switching and transmission systems of the provincial telephone companies. All of Atlantic Canada's telcos have significant and interesting capabilities. As an illustration, the New Brunswick Telephone Company Limited, (NBTel), whose head office is located in Saint John, is the major supplier of telecommunication services in New Brunswick.

NBTel, an established leader in modern products and services, has more than 300,000 customers. A major milestone occurred in November 1993, when it completed Canada's first, fully digital, provincial switching network. NBTel has also undertaken the construction of a comprehensive fiber-optics network. Among its "firsts" was the launch of the full-scale trial of integrated services digital network (ISDN) and the introduction of 800-PLUS service, community calling and call management services, including call-display. As part of its information highway initiative, NBTel is currently planning to install broadband interactive services which will include electronic malls and video home shopping, video movies and a variety of government services on demand.

Maritime Telegraph and Telephone (MT&T) is the major service provider in Nova Scotia, and has a major stake in PEI's IslandTel telephone company; NewTel is the relevant carrier in Newfoundland and Labrador. These other telcos have equally noteworthy activities relating to the IH. For example, MT&T has established a finance and venture capital arm to support partnerships with major IH infrastructure-related firms to develop new capabilities. NewTel has formed NewTel Information Services, providing information solutions to business needs in the province.

2.4.2 Cable Operators

There are several cable operators in Atlantic Canada. One of the largest is Fundy Cable with total annual revenues of $52 million in 1996, a 20% increase over 1995. A full range of cable programming is available throughout most of Atlantic Canada. Moreover, cable operators are now starting to initiate partnerships in order to diversify into Internet access. A good example is Cable Atlantic's link with Hookup Communications and AT&T Canada for this service.

2.4.3 Satellite Linkages

Ground links to satellite communication are available to Atlantic Canada through Telesat Canada, which maintains ground station facilities in Atlantic Canada. Uplinks are equally as technically advanced as in any other location in the world.

2.4.4 Cellular

Cellular and wireless service is provided both through existing telcos and through specialized wireless/cellular firms. For example, MT&T's wireless subsidiary, MT&T Mobility, is showing growth in new customers that approaches 50% each year! This new, in-depth cellular service was highlighted during the recent G-7 conference in Halifax. Alternatively, cellular service is also supplied by competing carriers such as Cantel.

2.4.5 Microwave

Ground-based microwave network systems are in use in Atlantic Canada, most notably the one run by Nova Scotia Power to control and modulate its electric power grid. The utility has developed leading-edge data network capabilities based on terrestrial microwave, and can monitor and control its generation, transmission and utilization of electric power in real time. This puts it on the leading-edge of power utilities.

2.4.6 Internet Service Providers

There is no limitation on Internet access in Atlantic Canada. Familiar service providers such as iStar are widely available.

2.4.7 Alternative Carriers

In one of the most interesting and hopeful developments in Atlantic Canada, Fundy Cable (see above) has announced the formation of a telecom subsidiary, Fundy Telecom, to offer telecommunication services across New Brunswick.

Fundy Cable's entry into telecommunications promises to provide for an even more expanded and cost-competitive market for business customers. The company will spend $70 million over the next three years on capital projects, mainly for the development of a second province-wide fibre optic network.

It will sell capacity on its network to competing long-distance carriers, provide private line phone services for businesses and offer higher speed video teleconferencing services. It may also offer ATM services, a high-end Internet service to businesses and video transport for broadcasters.

2.4.8 Specialized Communication Systems

A good example of specialized communications systems is provided by the services of the New East Group. The Group provides specialized wireless communications links and distance marine communications through satellite. The firm already has revenues of over $6 million annually. Just a few of its products include: flightWATCH™ offshore flight-following and vessel tracking service; Military Aeronautical Communications System (MACs); and TeleOceanics™ global satellite and radio communications systems.

2.5 INFORMATION HIGHWAY EQUIPMENT SUPPLIERS

Although Atlantic Canada itself does not have an extensive hardware research and production capability in respect of the Information Highway, this is not critical because regional supply capabilities are sufficient to supply all the key elements. In some cases, for example large Central Office (CO) switches for telcos, suppliers from outside the region provide the hardware. Nevertheless there is a significant local electronics hardware manufacturing capability. Everything is available. This second-tier of infrastructure supply elements includes a full range of hardware, such as:

- Nortel (Regional) provides leading-edge information highway hardware, such as Central Office (CO) digital switches, whose capabilities are among the most advanced in the world; Key Terminal Systems; Branch Exchanges; Transmission Systems; and related connectivity products;

- alternative competing electronics suppliers such as Siemens (Regional), whose capabilities extend to broad-spectrum electronic systems including Switches, Telephone Exchanges, Key Terminal Systems, Transmission and many other systems;

- suppliers of high-speed data network switches and connectivity products such as Newbridge Networks Inc.;

- regional wireless equipment producers such as Simmonds Inc.;

- hardware assembly and electronics component manufacturing, such as COMDEV Atlantic;

- transmission hardware manufacturing, such as Nortel St. John's cable plant;

- connectivity hardware manufacturing such as Newtek Instruments;

- Computer Memory assemblies manufacturing such as Abbacom Logic; and

- custom engineering solutions such as provided by Siemac.

2.6 INFORMATION HIGHWAY DEVELOPMENT AND CONTENT CAPABILITIES

Backing the infrastructure hardware supply tier, is a third tier of hardware and services IH development organizations. The region's capabilities to develop information-highway hardware and services is excellent. The capabilities speak for themselves, illustrated as follows (many other examples in almost all categories could be cited besides those given here):

2.6.1 Technical Services

Nortel (Regional) provides leading-edge systems-level technical services for telcos and operators in the region. In support of Nortel equipment, the technical services office has to be technically proficient on literally the most advanced telecom equipment in the world. There is no limitation on the local technical support capabilities.

2.6.2 Systems Integration

Systems integration capability is available in the region, an example being NewTel Information Solutions. The company, which is a subsidiary of NewTel, the Newfoundland and Labrador telco, provides business solutions to problems of network development, databases, integration, and other technical demands. NewTel Information Solutions is actually Atlantic Canada's largest information technology company.

2.6.3 Local Area Networks

Local-Area Networks (LAN) development is available through SHL Systemhouse Ltd. A particularly interesting feature has been this company's networks development in partnership with MT&T.

2.6.4 Software Engineering

Software engineering is a strength in several Atlantic Canada locations, especially in the Halifax and Fredericton areas. In Nova Scotia, the industry produces revenues of $60 million annually from software development, about half of total revenues of $120 million, and employs up to 900 people. Software is a product that can be readily sold in any geographic market by a company located anywhere in the world. More than half of the companies generate sales in export markets.

The federal government, through the Atlantic Canada Opportunities Agency (ACOA) has directly supported software engineering components of the Atlantic Canada IH cluster.

To put software engineering capabilities in Atlantic Canada in perspective, the Software Industry Association of Nova Scotia (SIANS) has published a 1996 Directory of relevant firms. There are dozens of software firms in the area. They range from systems integrators like the DMR Group to niche specialty firms providing dedicated-purpose software programs.

Fredericton also boasts a cluster of firms in software engineering. Engineering graduates in N.B. have built-up renowned consulting firms, such as Neill and Gunther and ADI, which have important portfolios of foreign business. These consulting engineering firms are increasingly making use of sophisticated software technologies in design and process control. Concurrently, new firms are being formed that are pure software specialists.

"Software New Brunswick" – a directory of software producers – lists roughly 45 firms in the Fredericton area. These range from those that make heavy use of software applications to those that are dedicated software producers. In the middle of the spectrum are highly specialized firms such as Universal Systems. Its 35 employees develop software for mapping and geographic information systems. Several major firms have set-up operations in Fredericton. These include DMR and Unisys. In fact, Unisys has established a retreat or "think-tank" in the area where its employees from around the world go to exchange information and ideas on latest developments.

This sector is built almost exclusively on the quality of people. Very little capital investment in plant and equipment has been required to create the several hundred software engineering jobs.

2.6.5 Multimedia

Multimedia development is being pursued, most notably through the Stentor Resource Center. This development activity links Atlantic Canada telcos both to activities outside the region as well as allowing innovative local firms a "window" on multimedia developments.

2.6.6 Microelectronics

Electronics-based products can be designed and developed in Atlantic Canada through services of firms such as Applied Microelectronics Inc. Founded in 1981, Applied Microelectronics Inc. is an established leader in the design and development of electronics based products. Applied Microelectronics' technology and project management expertise help clients bring quality products to market quickly and cost effectively. The company's operating philosophy emphasizes collaborative teaming. By providing a fixed price, defined delivery time and specification guarantees, Applied Microelectronics assists clients in meeting manufacturing cost constraints.

The client's requirements are the main guidelines which drive any product development. Applied Microelectronics beings by providing an environment which has the people, the tools, and the technology necessary to not only design the product, but also to prepare for successful manufacturing and marketing. All elements of the product life cycle are considered, from concept to production, including quality, cost, schedule and user requirements.

2.6.7 Wide-Area Networks

Wide-Area Networks (WANs) can be developed in Atlantic Canada, capitalizing on the existing WAN and the development capability of Nova Scotia Power as well as the development capability of other interested units (e.g., Nortel). Although N.S. Power has the only major WAN capability in the region at present, further developments could readily be undertaken as required.

2.6.8 Call Center Development

Call Center development is underway in Atlantic Canada. Genesys Laboratories Canada, for example is a partnership between NBTel and Genesys Laboratories of California. The lab develops software and other technology for the call center industry.

2.6.9 Research and Consulting

Research, consulting and management capability is available through local firms, such as DMR. Many others could be cited.

2.6.10 Content and Multimedia

Multimedia is an emerging market, derived from the convergence of information media such as telephony, cable, internet, etc. Already an Atlantic Canada firm, Salter Street Films, is developing multi-media content packages for the IH The firm is well known for its series of films, children's entertainment's, videos and other products.

2.6.11 Hardware Development

Atlantic Canada does attract new hardware development as exemplified by the recently announced establishment of a Halifax R&D facility by Newbridge Networks. Top company officials stated that, "the region offers compelling reasons for information technologies to establish a presence here, including a rich pool of world-class university graduates, an attractive quality of life and a progressive approach to public-private partnerships, such as the one we are announcing (in Halifax)."

Newbridge designs, manufactures and sells a comprehensive family of high-speed data communication products, providing, for example, faster Internet access. Newbridge will also establish a new affiliate company in the province to develop equipment to perform to the highest standards of reliability in severe environments such as cellular/wireless, outside plant and shipboard applications. The two operations will create 50 highly skilled jobs within four years.

Newbridge will cooperate with local Nova Scotia companies to help stimulate the growth of local information technology companies and provide additional opportunities for Nova Scotians.

Another company that could be mentioned is Phase Atlantic of Moncton, N.B. A member of an international group of companies, Phase Atlantic is committed to delivering superior technology to the global wireless communications marketplace. It focuses on providing integrated solutions to filter, amplifier and subsystem challenges. Phase Atlantic is a fully-integrated design, engineering, and manufacturing facility contributing comprehensive RF design and development capabilities for low noise amplifier technology, utilizing SMT production techniques. A separate facility is configured for high volume filter-derived assemblies for the wireless markets.

2.7 RELATED RESEARCH CAPABILITIES

Backing information highway technology and service development are a number of significant research units whose activities related directly and positively on information highway. These research units are not necessarily developing specific products and services – although note that they often provide some direct inspiration – but they illustrate a level of skills and capability that underpin significant and meaning to the strategy of developing information highway services in Atlantic Canada. These include:

- Networks development such as the Atlantic Canada Organization of Research Networks (ACORN) initiative, dedicated to inter-operability as a high-speed research network in Atlantic Canada, forming part of the CANARIE National Test Network, and deliberately aimed at providing a test-bed for new IH services, hardware and software;

- distance education using the information highway, most particularly the research underway at Memorial University;

- specialized Marine Communications Systems being developed at CCMC;

- broadband demonstration projects such as NBTel's experimental offerings;

- research partnerships such as the Telecommunications Application Research Alliance (TARA); launched in 1995 by Nortel and MT&T, with the Technical University of Nova Scotia (TUNS) as the principal university affiliate, this initiative provides innovative opportunities to entrepreneurs for testing new IH applications on a private network. The network runs on a state-of-the-art high speed digital switch. Total funding is expected to be $15 million over the first 5 years;

- business research such as the Atlantic Provinces Economic Council (APEC);

- strategic councils such as the Information Highway Committee of the Technical University of Nova Scotia (TUNS); and

- provincial research initiatives such as Connections Nova Scotia, trying out new uses of the IH in that province.

2.8 RELATED BUSINESS SUPPORT

In turn backing the various information highway-related capabilities, there are numerous Atlantic Canada related business support units and functions. These include:

- investment funds, such as ACF Equity Atlantic, who can financially support growth companies throughout Atlantic Canada;
- software development support, such as the Software Industry Association of Nova Scotia (SIANS);
- co-operative business initiatives to improve services and marketing, such as the Atlantic Canada Telecom Consortium (APTC); and
- technology transfer services, such as those provided by Concept + of Moncton, NB, who do innovative product design for software, mechanics, industrial and electronic design.

2.9 RELATED PUBLIC SUPPORT

- technical training provided by formal institutions such as Dalhousie University and TUNS;
- specific regional economic development initiatives such as New Brunswick's Minister of Information Highway;
- federal government support, including ACOA;
- community support, highlighted by the example of renewal strategy shaped by the Greater Moncton Economic Commission;
- business intelligence linkages, such as "Strategis", provided through Industry Canada;
- technical data such as provided by the NRC's CISTI database;
- university skills significantly relevant to the IH, such as UNB's Computer Science grade;

- provincial government initiatives, such as Operation On-line;
- technical personnel supplied by community colleges such as Eastern College in Newfoundland
- related technical directions such as the Newfoundland and Labrador Association of Technical Industries (NATI); and
- specialized finance and venture capital options, such as MT&T's venture capital aim, accessible for information highway development.

2.10 COSTS

Costs are not a factor in limiting the cluster's technical capabilities and/or development potential. One study conducted for the federal government concluded that Halifax was an extremely cost-competitive location for manufacturing. This study did a comparison of various manufacturing activities in different North American locations. Halifax turned out to be the most cost competitive. Similarly, NBTel and the Province of New Brunswick commissioned a study examining operating costs in North America. The results show New Brunswick is the most cost effective telecommunications and data centre location in Canada and one of the most cost effective locations in North America. New Brunswick offers significant savings in operating costs – up to 24% – for both national inbound and national outbound calling.

3.0
CLUSTER DYNAMICS

3.1 MARKETS

The markets in the region are very diverse. Some are linked to telcos which make a significant difference to the "home" market for some firms.

New service applications, such as Call Centres, are emerging. In N.B., Premier McKenna champions the development of the IT sector. The regional orientation of the markets has meant that exports and international marketing are not well developed. A large number of small firms are competing in a limited regional market.

Content for the information highway is emerging as a major market opportunity.

3.2 LOCAL/REGIONAL LINKAGES

Because of the diversity of firms in terms of products and services in the cluster there is closer interaction at the sub-cluster level where the communality of interest is more evident (e.g. multimedia). For example, 35 multimedia companies have come together to form MEDIAfusion, a "virtual" corporation whose mandate is to: identify project opportunities, carry out market research, find export opportunities, identify sources of capital and carry out public relations and awareness. These companies whose largest concentration is in Sydney, N.S., work together for the purposes of cooperative marketing, technical/sales support and joint ventures in product development. Fredericton also has a concentration of IT firms that have links with the UNB computer science department.

Another sub-cluster model is Atlantic Animation House which provides with its three subsidiaries a "total solution" to small companies wishing to advertize or sell on the Internet. The firm also forms alliances with other firms (e.g. Munin Multimedia Solutions to develop an entertainment CD of the Oak Island story).

The Telecom Applications Research Alliance (TARA) brings together large corporations, small software firms, educational and research institutions to test their applications on a live private telecom network. TARA, launched in August 1995, was established by MT&T, Nortel and the NS Government to foster increased applications research and to provide a link to national research initiatives such as CANARIE.

Other examples of linkages include:

- Salter Films with Pixel in Motion;
- EDIPORT Atlantic, a joint venture between the Port Authority and DMR;
- AMI is developing the interface for Weather Channel's information retrieval and distribution system for cable companies;
- Iotech developed a radar display system with CCMC and Nautel; and
- Seimac has worked with NS Power to establish a remote meter reading system for rural areas.

There are also on-going customer-supplier "partnerships" between the larger players such as telcos and Nortel.

3.3 EXTERNAL LINKAGES

External linkages fall into three categories:

1. firms that are indigenous to Atlantic Canada and link to outside firms (e.g. telcos);
2. firms located in Atlantic Canada but with head offices elsewhere (e.g. DMR); and
3. indigenous firms which focus on exports (e.g. Cochran, Marshall).

Most of the hardware is imported into the region where some value is added (i.e. 5-10%). The larger players have sales offices (e.g. Nortel, Lucent, IBM). On the software side there now are more possibilities to source locally (e.g. DMR, MCM, Cybersmith, Pixel Factory, Anderson Multi-Media) including systems integration (e.g. MIT, SHL).

However, most local software companies lack business and marketing experience. This can place them at a disadvantage in penetrating the regional market compared with firms from outside the region. As well, local firms lack the international marketing skills to penetrate other markets.

3.4 INFRASTRUCTURE

3.4.1 Technical Support

Demand for skilled people in IT exceeds supply. The higher the skill level required the more difficult it is to get people.

Highly skilled professionals are likely to have better opportunities outside the region. Those attracted from outside the region tend to leave after a while.

It is difficult to fill the gap through relationships with universities because of the differences in culture and expectations between industry and university.

More private schools are cropping up to provide technical training in IT (e.g. MacKenzie College, ITI).

Major R&D activities are done outside the region. There are some exceptions, such as NBTel's work on broadband with Nortel for the Vista 350 phone. The establishment of TARA was to create an R&D focus in the region.

3.4.2 Business Support

Capital is increasingly available. However, "smart" capital (i.e. strategic investment capital) to help emerging firms grow is lacking. Some firms go outside the region for venture capital because it provides them access to additional markets.

3.5 SUMMING UP

The diversity of firms mitigates against cooperation, except at the level of nodes (e.g. multimedia) where there is more common interest.

Most innovative firms are small and lack the managerial and marketing expertise needed to grow (e.g. access financing) and to penetrate other markets.

Demand outstrips supply for IT professionals.

4.0
ISSUES IN CLUSTER DEVELOPMENT

4.1 OVERALL CLUSTER STRATEGY

Atlantic Canada has a complete service capability on its information highway. Virtually all information highway elements are present in the region to serve existing markets and applications. Moreover, a number of significant new markets and applications are already emerging in Atlantic Canada to take advantage of information highway capabilities. Although Atlantic Canada does not presently have extensive research or production facilities for information highway – related hardware, this in not critical to profitable future services development in the region. Moreover, the prospects for expanding such hardware capabilities in Atlantic Canada will likely be enhanced through offering leading-edge services. In sum, information highway services represent a real strength in Atlantic Canada, and if new and/or enhanced service capabilities can be developed there will be the opportunity to gain in trade in services and jobs in Atlantic Canada through:

- sales of the software, management skills and consulting, systems integration, and other capabilities that underpin any new services;
- growth of user industries that will gain competitive advantage from novel application of information highway capabilities; and
- new opportunities to attract investment (from within and outside the region), both to develop profitable services, as well as to develop related capabilities such as hardware manufacturing.

Accordingly the major issue facing Atlantic Canada is how best to encourage the kinds of market research, software development, and “most-demanding-customer” market in the region for information highway services.

4.2 ISSUES

Although the information highway represents a real strength to the region, nevertheless several issues can be discerned concerning how best to encourage new/enhanced service delivery. They include the following.

If service market and applications are critical for the future development of the Atlantic Canada Information Highway cluster, then an issue remains, the limited market research and international marketing capability of firms in the region.

Although Atlantic Canada does cover a complete IH services spectrum, there is a need to deepen these capabilities.

New services have the great advantage over hardware of not requiring large-scale capital investment before production can commence. However, distribution remains an issue. Content producers need access to retail, marketing and infrastructure venues.

If the strategy of new services is accepted, then a major, if not the biggest, barrier to Atlantic Canada exploitation of this option is *software* skills. The IH infrastructure is in place. The physical underpining of services on the IH is software, not hardware. While the Atlantic Canada IH cluster includes significant software engineering capability, the issue still remains as to whether it can be further grown for a "services" strategy.

4.3 POTENTIAL PROJECTS

Taking concurrence with a "services" approach to growing the Information Highway cluster (with supporting hardware development if appropriate and justified), some potential project developments could be:

- using Atlantic Canada as a "most demanding customer" for new I.H. development, in particular building on initiatives such as "Vista phones". To make this strategy work, Atlantic Canada needs organized market research efforts to identify unfulfilled needs in the IH markeplace, and a follow-up mechanism to encourage and support "solutions" development;
- extending the TARA project concept to include further players, and/or developing parallel initiatives; and
- developing more "smart" venture capital capability to offset limitations on access to financing; problem may not be access to financing per se, rather, "smart" management "packages" that include marketing and other support. Action could include business seminars, attraction of external investment managers to the region, and supporting new consortia that bundled venture capital and specialized management expertise.

II THE ATLANTIC CANADA GEOMATICS CLUSTER

1.0
HIGHLIGHTS

The Atlantic Canada Geomatics cluster features a wide range of capabilities and has diverse markets. However, these markets tend to be locally-based. Emerging opportunities certainly do exist outside the region, and an issue for the cluster is how to develop a wider-ranging market orientation and marketing capability for its skills.

The first tier of Atlantic Canada's geomatics cluster has broad capabilities. These include:

- oceans geomatics;
- airborne-based geomatic searching and analysis;
- hydrographics;
- numerous and diverse software capabilities;
- systems development capability;
- ocean mapping;
- data interpretation;
- data management;
- image processing; and
- high-technology maps.

Backing this first tier of geomatics capabilities is a significant second tier of specialized geomatics-related support companies which add to the cluster's capabilities. These include:

- geomatics research;
- oceans research networks;
- university research;
- geomatics directories;
- Atlantic mapping;
- Geographic Information Systems (GIS);
- procurement support and development partnerships by more than one level of government;
- oceans-related technical networks;
- explicit provincial geomatic programs;
- training, education in geomatics specifically; and
- management and research consulting.

Geomatics is a sector with a broad base of expertise.

However, the regional market is limited and firms have increasingly to go outside the region to get business. This means that they have to develop international marketing skills.
Costs are not a particularly limiting factor to the current sales of the cluster, but the investment costs of sustaining a global or even continental marketing thrust would be a significant factor in the cluster's future development.

Issues needing attention include:

- Would it be feasible to enhance the focus of the cluster in the sense of developing a larger, integrating organization that had marketing strength, and that could enhance the technical capabilities of the cluster?

- How best to develop a wider-ranging marketing capability?

- How best to develop better management and marketing skills at the level of the firm?

- How best to develop local informal and formal venture capital pools that specifically address the needs of the IT sector?

- How to bridge the skilled personnel gap?

Some specific potential project developments for the cluster could be:

- Placentia Bay traffic management project; NOVALIS is an example for further co-operative "solutions" projects;
- "outsourcing" for solutions by government clients, e.g. DFO, DND, others, with less emphasis on "in-home" integration; ACOA could possibly facilitate this very important option;
- "Port of Halifax" solutions;
- further infrastructure development, e.g., capability to put geomatics directly onto IH; this would require development of common standards and access mechanisms;
- market development, especially World Bank projects, possibly using CIDA projects for developing "solutions" capability; and
- co-operative student training programs, both for skills development and as a long-run marketing capability.

Exhibit II-1 gives an overview of the Atlantic Canada geomatics cluster. Exhibit II-2 summarizes the current development status of the geomatics cluster against the eight ingredients of success. The cluster has to address issues related to seven of the eight elements of success in order to move aggressively to the next stage of development.

Exhibit II - 1: Atlantic Canada Geomatics Cluster

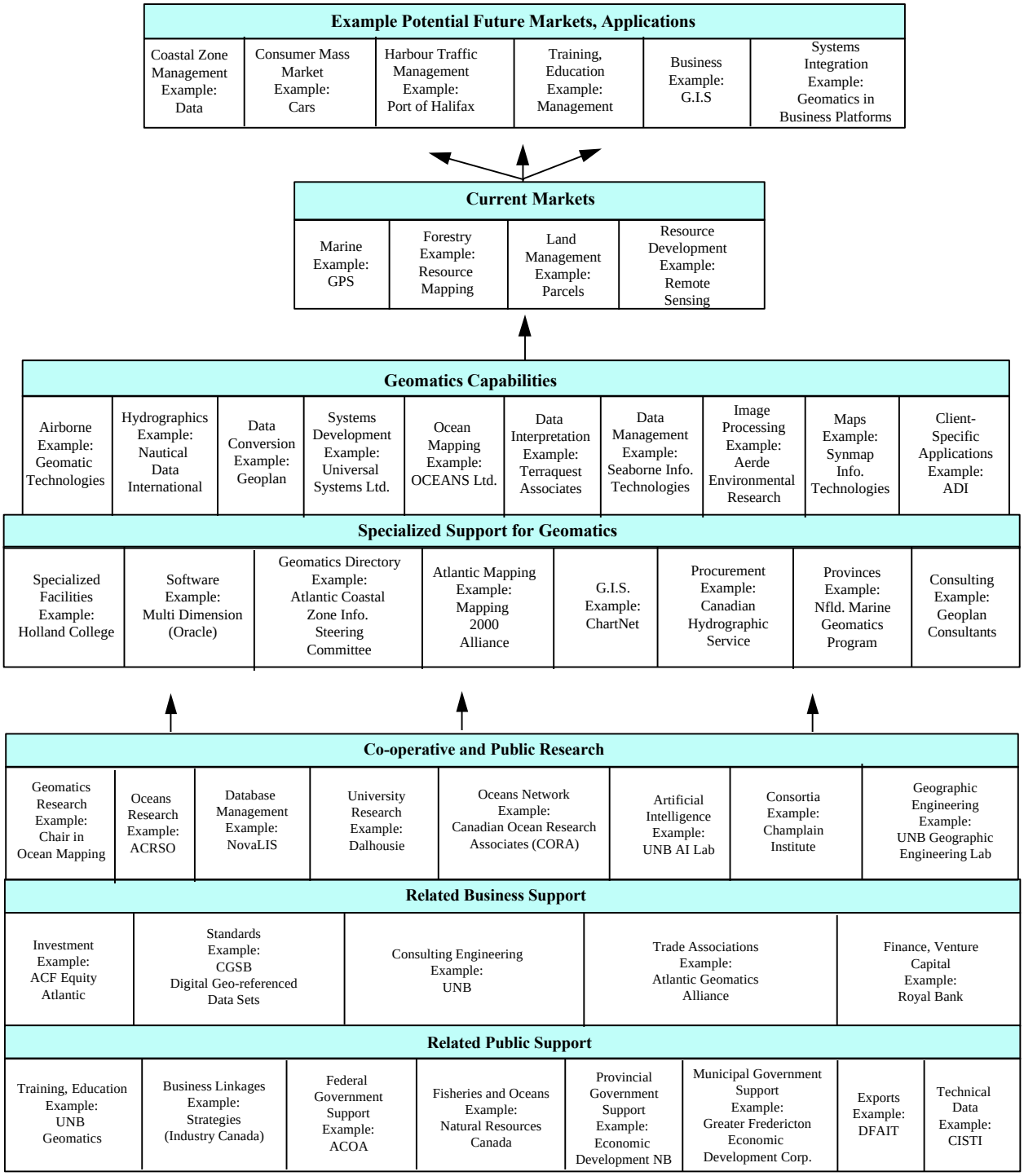
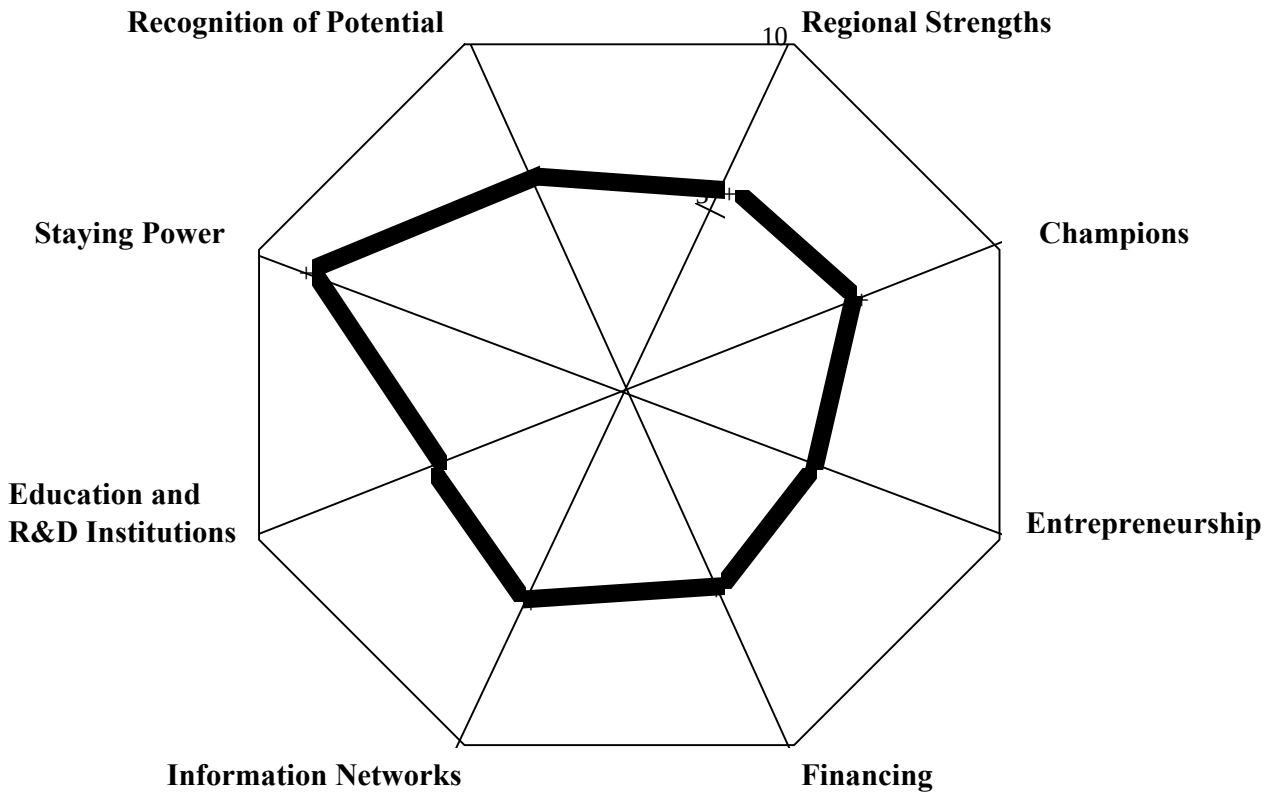


Exhibit II-2: Development Status of the Atlantic Canada Geomatics Cluster



2.0
CLUSTER PROFILE

2.1 CURRENT MARKETS

The Atlantic Canada geomatics cluster targets a number of promising markets. At present, it is largely oriented to land-based resources and Atlantic ocean mapping. The total range of markets includes:

Marine Geomatics

A good example of this market is the sale of Global Positioning Systems. Several Atlantic Canada firms are active in this technology. The market demands precision location-finding at long range in harsh environmental conditions, which is very challenging technically;

Forestry

A good opportunity in this market is resource mapping - particularly relevant in New Brunswick. Many Atlantic Canada firms are active, and their responses are a strength of the cluster. This market may well become more demanding in light of the issues of sustainability;

Land Management

Numerous municipalities in Atlantic Canada are active in the use of geomatics capabilities for land management such as zoning. Atlantic Canada has been in the forefront of these techniques and thus this market has been a prime one for the cluster, indicating strong skills in this area; and

Resource Development

One of the most important markets for the cluster and likely to become even more important. A good example of the opportunity is remote sensing. Several Atlantic Canada firms are already involved in this activity. Moreover, the cluster addresses many of the specific technical needs of this market. This market will go on demanding even more accurate image interpretation, data collection, and sensor inputs - very challenging, and it is a positive sign of the cluster's technical capabilities that this market is already in focus by the cluster.

2.2 POTENTIAL FUTURE MARKETS, APPLICATIONS

In the future, other markets could exist, such as:

Coastal Zone Management

Changes over the last 20 years related to Coastal Zones have highlighted the need for reconnaissance and management of Coastal Zones. Issues include environmental damage, weather forecasting and climatology, shipping traffic safety, search and rescue and underwater resource development. This market demands capabilities to collect, analyze and interpret enormous quantities of data;

Consumer Mass Market

This market has not yet been taken on by the cluster but it remains an emerging opportunity with large-scale sales potential world-wide. The first examples of GPS fitted to cars are now available on high-end vehicles. Large highway tracks have been using similar systems for the last few years. This market will demand low-cost mass production. However, several studies have shown that Atlantic Canada is a cost-competitive location for manufacturing;

Harbour Traffic Management

The proposed expanded Port of Halifax would involve a tripling of shipping throughput at the Port. New demands on traffic management will inevitably exist. (For example, safety of "Panamex" ships) This is a significant specialized local opportunity for the cluster; and

Training, Education

Atlantic Canada attracts many foreign and Canadian students from outside the region to its universities each year. The region's capabilities could be used as the basis for enhanced educational services, especially at the post-graduate level and with a business specialty orientation.

New Business

An example of entirely new businesses coming out of the cluster would be commercial Geographic Information Systems (GIS). This opportunity could be exploited by sales to travel organizations, governments, shipping firms, manufacturers and resource managers. Already several firms in Atlantic Canada are involved in developing, processing, handling and storing this kind of information.

Systems Ingration

An important market opportunity for Atlantic Canada's Geomatics cluster can be summarized as developing integrated business platforms that include geomatic capability. An example of such a business platform would be a database system that indicated "just-in-time-delivery" solutions across international markets; the market would be substantial, especially for high-growth firms using a complex mix of air/surface transport.

2.3 TOTAL OUTPUT

A survey of Atlantic Canada geomatics firms was conducted in August 1994, by the Canadian Institute for Research on Regional Development (University of Moncton). This survey identified 62 firms as being active in the geomatics sector in Atlantic Canada (although close to half of these "active" firms only had 25% of their total revenues coming from geomatics). According to this report, total sales were $15 million in 1992, and the firms had about 375 employees. Most of the firms involved are small, with less than 10 employees. However, growth has been fairly rapid, and a target of $50 million in annual revenues was hoped for by 1996 although data does not yet exist to confirm it.

Moreover, the value of co-operative and public research level, and related business and public support networks, should be added to this figure to get a true picture of the total cluster output. Nordicity estimates these values as currently being approximately $20 million annually. Total cluster value, accordingly, would be in the range of $35 million to perhaps as much as $70 million.

2.4 GEOMATICS CAPABILITIES

The geomatics capabilities in Atlantic Canada are very wide ranging (see Exhibits II-3 and II-4). Accordingly it is necessary to illustrate the capabilities both in terms of the spectrum of functions, and the related firms. It should be noted that *both* capabilities and firms are more extensive than listed here. However, these examples do serve to show the breadth of the cluster's capabilities.

2.4.1 Airborne Sensing

A technically very demanding capability is airborne sensing. The tasks include image interprotection, mapping services and data collection. The essential problem is the lack of physical contact with the ground or sea, putting a premium both on comprehensive knowledge of the terrestrial landscape and seascape, and the ability to interpret sensor images and data. Firms in this area include Geomatic Technologies Inc.

Exhibit II-3: Atlantic Canada Geomatic Capabilities (Equipment & Software)

Equipment/Software / Companies	Digital Mapping	Geographical Information Processing	Image Analysis	Multispectral Scanner/Aerial Camera	Satellite Image Reception	Satellite Positioning	Other
New Brunswick							
ADI Limited							
Applied Management Consultants							
Applied Spatial Information Inc.							
ASG - Atlantic Systems Group		●					
CAD/CAM Systems Ltd.	●	●					●
Document Searching Services							
Fiander-Good Associates Ltd.							
Geodat Information Services Limited							
Geomacadie Services Ltd.							
Geoplan Consultants Inc.							
Hughes Surveys & Consultants Ltd.							
ICOIN Industries Inc.		●					
Jacques Whitford Environment Limited							
Northeast Exploration Services Ltd.							
OPTEX Inc.		●					
REMS Soft Inc.							●
SPIDER International Ltd.							
Strategic Ventures Corp. (SVC)							
Three-D GeoConsultants Ltd.							
Universal Systems Ltd.	●	●					
Washburn & Gillis Associates Ltd.							
Newfoundland							
Centre for Cold Ocean Resources Engineering							
Compusult Limited		●					●
Data Services International Inc. (DSI)							
Geodata Ltd.	●	●					
Geo-Resources Inc.							●
Nautical Data International Inc.	●	●					●
Nova Scotia							
AERDE Environmental Research							●
AGI Ariel Geomatics Incorporated							
Canadian Seabed Research Limited							
DataQuest Inc.		●	●			●	●
The Eastcan Group of Survey Consultants Limited							
Geomarine Associates Limited							
L.I. Geomatics Limited							
NovaLIS Technologies Inc.							●
Satlantic Inc.				●	●		
Sirius Solutions Limited			●				
Thompson Conn & Associates							

Exhibit II-4: Atlantic Canada Geomatic Capabilities (Services)

Companies \ Services	Aerial Photography/Surveying	Cartography	Consulting (Geomatics)	Data Base Management	Engineering Surveying	Geodetic/Control Surveying	Geophysical Surveying/Data Procesing	Hydrography	Image Analysis	Land/Geographic Information Processing and Consulting	Land Surveying	Mining Surveying	Navigation or Offshore Surveying	Orthophoto Production	Photogrammetric Mapping	Photographic Processing	Remote Sensing	Software Development	Training in Geomatics	Other
New Brunswick																				
ADI Limited					●	●				●									●	
Applied Management Consultants			●							●										
Applied Spatial Information Inc.			●							●										●
ASG - Atlantic Systems Group										●										
CAD/CAM Systems Ltd.										●								●	●	
Document Searching Services				●						●								●		●
Fiander-Good Associates Ltd.		●			●					●										●
Geodat Information Services Limited			●						●	●								●	●	
Geomacadie Services Ltd.		●	●						●	●				●			●			
Geoplan Consultants Inc.			●	●	●	●		●		●	●								●	
Hughes Surveys & Consultants Ltd.		●			●	●		●		●	●	●								
ICOIN Industries Inc.																				
Jacques Whitford Environment Limited				●						●										●
Northeast Exploration Services Ltd.									●	●				●			●			
OPTEX Inc.										●								●		●
REMS Soft Inc.										●								●		●
SPIDER International Ltd.								●		●									●	●
Strategic Ventures Corp. (SVC)			●																	●
Three-D GeoConsultants Ltd.										●										●
Universal Systems Ltd.										●								●	●	●
Washburn & Gillis Associates Ltd.										●										●
Newfoundland																				
Centre for Cold Ocean Resources Engineering			●																	●
Compusult Limited				●														●	●	●
Data Services International Inc. (DSI)			●	●					●									●	●	●
Geodata Ltd.	●	●				●			●						●			●		
Geo-Resources Inc.								●												
Nautical Data International Inc.								●												
Nova Scotia																				
AERDE Environmental Research	●									●							●		●	
AGI Ariel Geomatics Incorporated																	●			
Canadian Seabed Research Limited					●		●	●				●	●				●			
DataQuest Inc.			●														●	●		●
The Eastcan Group of Survey Consultants Limited	●	●				●		●		●					●					
Geomarine Associates Limited							●													
L.I. Geomatics Limited	●		●	●	●		●			●	●		●					●		
NovaLIS Technologies Inc.			●															●		
Satlantic Inc.									●								●	●		
Sirius Solutions Limited			●					●	●									●		●
Thompson Conn & Associates	●					●					●				●					

2.4.2 Hydrographics

Charting the sea is a task mariners have long had to cope with but modern shipping and air traffic speeds make it, literally doubly difficult. *Information* is the key ingredient. Firms in hydrographics include Nautical Data International (NDI).

NDI specializes in the production and distribution of digital hydrographic and other data products to serve the needs of users of Geographic Information Systems (GIS), including the modern navigators who use the GIS known as the electronic chart. NDI has signed an exclusive agreement with the Canadian Hydrographic Service (CHS), the custodian of Canada's hydrographic data, that establishes NDI as the sole source for CHS electronic charts and other digital nautical data products.

The range of applications for digital nautical data spans a wide cross-section of industrial, scientific and government activities, including vessel navigation, offshore resource mapping, and coastal zone management. As the official distributor of CHS digital products, NDI can provide CHS-certified digital charts and other digital nautical publications for these applications. The products can be delivered in international standard formats, such as DX-90 or DIGEST VPF, or can be customized to meet client requirements.

NDI operates a production facility for GIS data conversion and data structuring to prepare data products in standard and customer formats. The company utilizes most commonly used exchange media, including floppy disk, data-guide DAT and other type formats, and CD-ROM, and can also deliver data products floppy disk, data-grade DAT and other tape formats, and CD-ROM, and can also deliver data products over the Internet. NDI also offers services to clients interested in the development of production and distribution methods for digital data products. In concert with the Canadian Hydrographic Services, NDI can organize effective forms of collaborative and contractual co-operation to help make the digital ocean a world-wide reality.

2.4.3 Data Conversion

The stream of data available from various sensors and platforms has to be reduced to appropriate analog or digital information. Such data conversion work is undertaken by many Atlantic Canada firms. An example is Geoplan Ltd.

2.4.4 Systems Development

The software development and database capabilities of the cluster are backed up by relevant computer systems and information management systems. Some firms in the cluster with these skills include:

- Universal Systems who develop state-of-the-art computer systems for client-specific solutions;

- Datacor/ISM Atlantic is a joint venture of the New Brunswick Telephone Company, Limited, ISM Information Systems Management Corporation and Blue Cross of Atlantic Canada. The primary business is the management of complex systems on a variety of mainframe, midrange and LAN platforms as well as network and LAN/WAN Management Services. Datacor/ISM provides these systems operations services throughout Atlantic Canada and manages national services in value added networks;

- Maritime Information Technology works with larger corporations to achieve business re-engineering through new technology in Open Systems and Client Server Computing. MIT services include Facilities Management, Systems Integration, Application Development and Implementation Services. MIT currently serves clients throughout New Brunswick and Atlantic Canada; and

- SHL Systemhouse is a world leader in the systems integration industry and an internationally active company. Systemhouse in Atlantic Canada offers clients fully-integrated computer-based systems, combining hardware, software and communications. The company specializes in leading edge Client-Server solutions and has implemented many successful projects using this technology.

2.4.5 Ocean Mapping

The Atlantic Canada cluster has extensive experience with ocean mapping. The areas of particular concern involve environment, ice and wave patterns. Example companies active in ocean mapping include OCEANS Ltd. The company provides image processing systems/software, ground stations/processors, sensors, image interpretation/mapping services (environment, ice and oceans).

2.4.6 Data Interpretation

Knowledge of the terrestrial surface is the vital background to leading-edge sensor techniques for data interpretation. There are numerous firms specializing in data interpretation in the cluster. This is a technology with an ever-more demanding profile. Example in the cluster doing data interpretation work include:

- Universal Systems - image processing systems/software, image interpretation/mapping services (agriculture, land use, environment, hydrology, forestry, earth sciences/geology, ice and oceans, cartography), training/training materials; and
- Terraquest Associates.

2.4.7 Data Management

Related to the software engineering and systems development capabilities is data management. The same demanding profile of data volume applies. Companies in the cluster active in data management include:

- Seaborne Information Technologies; and

- Andersen Consulting Canada - part of an international management and technology consulting organization with more than 26,000 people in 151 offices in 47 countries. The organization provides clients with the following professional services: Strategic Services, Systems Integration, Business Process Management, and Change Management Services. the firm helps public and private sector clients throughout Canada and the world, and encourages the import and export of leading edge technologies. The firm has over 650 professionals in eight Canadian offices, including the newest location opened this year in Fredericton, New Brunswick.

2.4.8 Image Processing

Related to image interpretation is image processing. Modern digitized techniques are vital to this process, along with multi-media sensor input such as optical, visual, photographic and radar. Firms in the cluster include:

- Aerde Environmental Research - image processing systems/software, image interpretation/mapping services, (agriculture, land use, environment, hydrology, forestry, earth sciences/geology, ice and oceans), training/training materials; and

- Jacques Whitford Environment Ltd. - image processing systems/software, image interpretation/mapping services (agriculture, land use, environment, hydrology, earth sciences/geology, ice and oceans, cartography), training/training materials.

2.4.9 Maps

Modern digitized technology allows new-generation mapping, “smart maps”, computer image maps, etc. A firm in the cluster in this technology is Synmap Information Technologies Ltd. - image interpretation/mapping services (environment, earth sciences/geology).

2.4.10 Client-specific Applications

Several firms in the region provide new, client-specific software solutions for new geomatics applications. Just one example is ADI Inc., who provide various control and processing programs.

2.5 SPECIALIZED SUPPORT FOR GEOMATICS

There is a second tier of specialized support to the Atlantic Canada geomatics cluster, as follows:

2.5.1 Software

Geomatics is among the most demanding of software customers owing to the sheer volume of data that must be available in real time. The Atlantic Canada geomatics cluster includes the largest data base in the world - a real tribute to the cluster's technical capabilities. An example firm in this market segment is Oracle Canada.

Oracle, the third largest software management corporation in the world, has joined with DRM and Unisys to form a consortium under the name of the Oracle Support Centre. Combining the resources of the three companies, the Support Centre now commands the largest data base in the world Currently, the Centre is concentrating on meeting the information management needs of New Brunswick provincial government projects.

2.5.2 Geomatics Directories

An example of a geomatics directory in Atlantic Canada is that of the Atlantic Canada Coastal Zone Information Steering Committee.

Version 3 of the Atlantic Coastal Zone Database Directory, compiled by the ACZISC, lists and describes 608 databases of relevance to the integrated management and sustainable development of the coastal zone of Atlantic Canada. The database descriptions include such details as contact persons, availability, formats, geo-referencing, scales, etc. The databases are maintained by governments (federal, provincial, municipal/regional), academic/research institutions, the private sector, non-governmental organizations, and non-profit organizations.

Other directories exist in Atlantic Canada. One on the World-Wide Web is run by the provincial government of New Brunswick. Another one is the one prepared by the Newfoundland and Labrador Association of Technical Industries (NATI).

2.5.3 Mapping

The Mapping 2000 Alliance

The Mapping 2000 Alliance was created to develop improved maritime safety techniques for Canada as well as for other countries. The members of the Mapping 2000 Alliance are:

- Nautical Data International, Inc. (St. John's, NF);
- Canadian Hydrographic Service (Ottawa, ON and 5 other locations across Canada);
- Compusult Limited (St. John's, NF);
- Universal Systems Ltd. (Fredericton, NB);
- Oracle Corporation Canada, Centre de Recherche Outaouais (Hull, QU);
- IDON Corporation (Ottawa, ON);
- University of New Brunswick (Fredericton, NB); and
- Canadian Centre for Marine Communications (St. John's, NF).

The Mapping 2000 Alliance is the culmination of many past strategic working relationships that include:

- The formation of NDI by Canada's two electronic charting firms, Offshore Systems Ltd. of B.C. and Matrix Technologies of Newfoundland;

- A long term marketing and distribution agreement between NDI and CHS that will contribute to the commercialization of digital mapping technologies;

- CHS and IDON have worked closely in the past on a variety of geomatic matters which included leading the development of national and international geomatic standards and feasibility studies for distributing and updating electronic navigation charts;

- USL and CHS have worked together to develop GIS software and have established a market niche in hydrography. USL is a CHS partner in the development of new systems for electronic chart production and hydrographic data processing and management;

- Oracle and CHS have collaborated on developing extensions to well-established RDBMS products to manage the very large volumes of hydrographic data; and

- UNB and CHS have collaborated on a program of research and development in Ocean Mapping to provide complete imagery of the ocean bottom as well as many other geomatic projects.

The common objective of the Alliance is to join Canadians working from Vancouver to Newfoundland in pushing the learning curve out so that Canada can lead the world in applying new technology to producing better nautical chart products, and thereby contribute to major improvements in marine safety.

2.5.4 Geographic Information Systems

ChartNet is a fully integrated geomatics information system for the production, management and distribution of GIS data products. The system is being developed by the Mapping 2000 Alliance with nautical Data International as lead contractor.

Designed to operate on distributed geomatics databases in local or wide area networks ChartNet will allow multiple workers on the network to engage in collaborative production, quality control, and maintenance. The system incorporates advanced facilities for the management and dissemination of data products, and provides end users with a highly-evolved capability for access to meta-data and data products.

ChartNet will be a tool for organizations involved in the handling of GIS data for planning, resource management, military and other applications. The first phase of the ChartNet development project - the delivery of a system for CHS and NDI - will be completed in the spring of 1995. The project is supported by the Canadian Network for the Advancement of Research, Industry and Education (CANARIE), CHS, the National Action Committee on Ocean Mapping, and other agencies.

2.5.5 Procurement Partnerships

The Canadian Hydrographic Services (CHS) has deliberately sourced from local Atlantic Canada suppliers. NDI is an example.

2.5.6 Education, Training

The College of Geographic Sciences (COGS) in Lawrencetown, N.S. is a small, specialized, high technology campus, the College of Geographic Sciences is part of the Nova Scotia Community College network. It concentrates on training at a variety of post-secondary levels and post-graduate level in subject areas that fall under the Information Technology area, particularly those with a geographic basis. The focus of the entire campus is on the Geomatics and Information Technology industries and associated public agencies.

2.5.7 Provincial Programs

An example of a provincial geomatics program is Newfoundland’s Marine Geomatics Program.

2.6 CO-OPERATIVE AND PUBLIC RESEARCH

2.6.1 Geomatics Research

Each year the federal government's Natural Science and Engineering Research Council (NSERC) supports industrial research chairs at Canadian universities. Dalhousie University in Halifax has been successful in attracting a Chair in Ocean Mapping. This research links the university's geomatics research to local firms.

2.6.2 Oceans Network

A capability based on remote sensing of the oceans is centered in Halifax and involves a network of firms across Atlantic Canada. It is represented by the Atlantic Centre for Remote Sensing of the Oceans (ACRSO) which was started in 1993 with help from ACOA and the provincial government. One of its founding members was Satlantic Inc., a firm spun-out of Dalhousie University. ACRSO now has approximately 150 members of which about 50 are in Atlantic Canada. Some 50% of revenues come from membership fees and a newsletter that has a world-wide distribution of 10,000 copies. The centre originally focused on firms interested in satellite information but now includes those working on SONAR/RADAR and synthetic aperture radar (SAR) from airborne and satellite sources. The organization has a budget of $500,000 per year. It is a clearing house for the latest information in the field and represents the interests of members at trade shows and offers computing and advanced printing facilities.

2.6.3 University Research

A great deal of the cluster's capabilities can be traced to area universities. A particularly good example is the University of New Brunswick's engineering school, which has led to many engineering consulting firms in the area. This base is directly relevant to the Geomatics cluster. Similarly, Dalhousie University conducts geologic/geomatic research. Relevant units include the Geological Research Laboratories, which includes labs dedicated to: Electronic Microprobe and Image Analysis, Mineral Separation and Preparation, Fission Track Research, Argon Laserprobe Dating, and Thin Section.

2.6.4 Federal Government Research

The Bedford Institute of Oceanography (BIO) is Canada's largest center for ocean research. BIO conducts research mandated by government, advises on marine environments including fisheries and offshore hydrocarbon resources, provides navigational charts, and responds to environmental emergencies.

BIO is administered by the federal Department of Fisheries (DFO), both on its own behalf and for the other departments that maintain laboratories and groups at the Institute, including Natural

Resources Canada and Environment Canada. Its activities include geomatics-related research, such as:

- Canadian Hydrographic Service - BIO is charged with the task of measuring and describing the physical features of Canada's navigable waters and their marginal land areas and for making this information available in a suitable format; and

- Marine Environmental Geoscience - Coastal and marine sedimentary processes are studied to determine their influence on environmental systems and the impact of resource use and development. The geology, basin structure, tectonic evolution and hydrocarbon generation of sedimentary basins are also evaluated to determine their oil and gas supply potential.

2.6.5 Consortia Research

The Champlain Institute (CI) is a private sector initiative to promote internationally the capabilities of member geomatics companies from the Canadian Maritime provinces. Formed in 1995, the members bring a wide variety of capabilities and experiences and through the CI, provide a focused, full-service effort for projects around the world.

Collectively, the Institute provides clients with a single point of contact for a complete range of products and services including:

- Geographic Information Systems (GIS)
- Global Positioning Systems (GPS)
- Land Information Management Systems (LIS)
- Land Records Management
- Mapping
- Management Consulting
- Surveying
- Training

The Institute has a broad base of geomatics applications including:

- Environmental Applications
- Healthcare Geomatics Marine Geomatics
- Remote Sensing Applications
- Satellite Applications
- Transportation Geomatics

2.6.6 R&D Partnerships with Provincial Governments

An example of R&D partnerships is provided by NovaLIS Technologies. Formed in 1992, NovaLIS Technologies is located in Halifax, NS, with a team of 27 professionals focusing on the requirements of land records management technology.

Atlantic Canada has long been recognized as being an important source of public and private sector expertise and experience in the Land Records domain. NovaLIS capitalizes on this expertise through public-private partnerships and relationships with the academic community. NovaLIS further extends this Atlantic Canada competence base by providing leading edge technology to bring the vision of integrated land records solutions to reality. NovaLIS is engaged in R&D partnerships, including the Province of Nova Scotia. The integrated NovaLIS product is being developed in partnership with the province of Nova Scotia.

2.6.7 Technology Alliances

Several technology alliances exist in the Atlantic Canada geomatics cluster. Examples include:

- Canadian Ocean Research Associates (CORA) - an alliance of oceans-related firms, and

- Alliance for Marine Remote Sensing - An international, not-for-profit association, the Alliance for Marine Remote Sensing (AMRS), develops and promotes marine applications of remote sensing technologies. In addition to providing traditional association services, AMRS offers technical services to members, and it meats with member companies in the development of applied research projects. AMRS believes its rapid growth is due primarily to this unique approach to R&D.

  Fish habitat, toxic blooms, ships, suspended sediments, coastal vegetation, surface currents and oil spills can all be mapped and monitored from space. With members in 28 countries, AMRS provides the network to link regional members to the international marketplace, and, thereby, can address any given application, regardless of its regional significance.

  Membership in AMRS is growing rapidly and has approximately doubled in each of the past two fiscal years and further increased by 70 per cent in the past six months. Although AMRS focuses mainly on industrial development, approximately 25 per cent of its 600 members come from the academic community, and another 20 per cent from public agencies. It is based in Bedford, N.S.

2.7 RELATED BUSINESS SUPPORT

The base of related business support to the Atlantic Canada geomatics cluster includes:

- consulting engineering skills and capabilities, such as those available from UNB and many area engineering firms;
- geomatics-specific database management such as the Land Resources Information System;
- Standards - the Canadian Government Standards Bureau's digital geo-referenced data sets; and
- finance and venture capital such as provided by banks and ACF Equity Atlantic.

2.8 RELATED PUBLIC SUPPORT

The base of related public support to the Atlantic Canada geomatics cluster includes:

- business links through Industry Canada's "Strategis" intelligence;
- federal government support;
- municipal government support;
- the Maritime Geomatics Board;
- technical support on markets, such as technical information provided by NRCan;
- technical data such as provided by NRC's CISTI; and
- exports and trade missions supported and/or developed by DFAIT.

3.0
CLUSTER DYNAMICS

3.1 MARKETS

The markets have historically been within the region. The genesis of the sector is surveying which is locally based. Applications are client specific. However, there is a growing exports component. Atlantic Canada is increasingly becoming known for its geomatics expertise.

The services and products developed in the region are among the best in the world. International markets are thus a natural growth area. Although some firms are active internationally, many smaller firms are just beginning to look beyond the local/regional markets.

3.2 LOCAL/REGIONAL LINKAGES

The need for cooperation between firms is increasing as new markets are pursued and issues common to many within the sector (i.e. training) are identified. Examples of linkages include:

- NDI and CHS;
- Compusult and MDA;
- Universal Systems (N.B.) and the Geomatics Information Centre (PEI);
- GSC (Atlantic) meets its requirements as much as possible through local/regional contracting-out (e.g. Geoservice, Nortek, Jacques Whitford, MacGregor GeoScience).

Government departments are increasingly entering into partnerships with private firms and universities. Government policy and budget cuts drive the formation of partnerships.

Firms will co-venture with other firms in those areas where they lack expertise.

The Champlain Institute, which is run by the private sector, tries to create “glue” among players in the three Maritime provinces by providing services in three areas: exports, educating and training, and R&D. The Institute would like an Atlantic Canada mandate.

3.3 EXTERNAL LINKAGES

While hardware and basic software (e.g. SPANs) comes largely from outside the region, applications are developed mainly from within the region. Only about 10-15% of a final geomatics products are sourced from outside the region.

International marketing is a problem. Cooperation exists at this level. The Champlain Institute, for example, represents its members at trade shows. The Geomatics Industry Association has led trade missions. A trade mission to China led to a large project for Jacques Whitford, for example.

3.4 INFRASTRUCTURE

3.4.1 Technical Support

Skilled people in geomatics are very much in demand. It's a very competitive field. Many Atlantic Canada graduates find employment outside the region. Many of the skilled employees needed by the sector are IT professionals. As referenced in the Information Highway cluster analysis, IT professionals are in demand and with geomatics being only one of many disciplines IT professionals can choose from geomatics firms lose out to the "pure" IT interests such as IBM.

Staffing remains a problem. Regional firms are marketing themselves more aggressively in universities and community colleges where training is available (e.g. UNB, COGs).

Training is a major issue and is a focus for the activities of the Champlain Institute. One problem is the lack of coordination among the programs being offered by universities (e.g. geography at Saint Mary; planning at TUNS, etc.). No graduate program exists in the region.

UNB is particularly strong in R&D.

3.4.2 Business Support

All financing instruments are used. However, the venture capital problem is overcome in part by developing applications for paying customers and hence can be financed internally.

3.5 SUMMING-UP

Geomatics is a sector that is a broad base of expertise.

However, the regional market is limited and firms have increasingly to go outside the region to get business. This means that they have to develop international marketing skills.

4.0
ISSUES IN CLUSTER DEVELOPMENT

4.1 CLUSTER STRATEGY

So far the cluster has oriented itself towards local markets. However, important opportunities exist outside the region. An issue for the cluster is how to develop a wider-ranging market orientation. Costs are not a problem at the current level of output of the cluster. However, they could present problems in terms of investments in international marketing.

4.2 ISSUES IN CLUSTER DEVELOPMENT

- How best to develop a wider-ranging marketing capability?
- Would it be feasible to enhance the focus of the cluster in the sense of developing a larger, integrating organization that had marketing strength, and that could enhance the technical capabilities of the cluster?
- How best to develop better management and marketing skills at the level of the firm?
- How best to develop local informal and formal venture capital pools that specifically address the needs of the IT sector?
- How to bridge the skilled personnel gap?

4.3 POTENTIAL PROJECTS

Taking concurance with the "systems integrator" approach, some projects could be:

- Placentia Bay traffic management project. NOVALIS is an example for further co-operative "solutions" projects.

  A Placentia Bay traffic management project could represent a major opportunity for the Atlantic Canada geomatics cluster. First, there is a wide range of ship traffic in the Bay, including oil tankers accessing refinery facilities, passenger ferries, commercial traffic (e.g., fishing boats), container shipping, pleasure craft, and miscellaneous sea traffic. All this variety of traffic has different speeds and potential for manouver. Second, the environmental conditions of rough seas, wind, tides and fog are very demanding. Third, there are substantial parallel opportunities to do such "sea traffic management" in Canada and globally once credibility has been developed in terms of "turn key" systems capability.
- "outsourcing" for solutions by government clients, e.g. DFO, DND, others, with less emphasis on "in-home" integration; ACOA could possibly facilitate this very important option.

This sort of project would require a new approach to procurement by government agencies. Typically in the past systems integration (for example, for fish stock inventory-taking and harvest exploitation) has been done "in-house" by such agencies as DFO and DND. It is possible that an "outsource" approach to systems integration, as opposed to integration by the client agencies themselves, could soon become both more cost/effective and a mechanism for industrial development. A possible compromise might be outsourcing under ACOA encouragement, of a particular segment of sub-system, e.g., sensing, communications, or data management.

- "Port of Halifax" solutions.

  It could be worth developing coastline and shipping lane traffic management for an expanded Port of Halifax. It is likely that such a project would involve developing an integrated approach to high-speed approach, turnaround and exit of container ships, including inter-modal transfer from sea-borne to land-based (e.g., rail) platforms. As well, there would likely be another dimension of general freighting, tracking, steamship handline, and pleasure/passenger traffic.

- further infrastructure development, e.g. capability to put geomatics directly onto IH; needs common standards and access mechanisms;
- market development, especially World Bank projects, possibly using of CIDA projects for developing "solutions" capability; and
- co-operative student training programs, both for skills development and as a long-run marketing capability.

III THE ATLANTIC CANADA AQUACULTURE CLUSTER

1.0
HIGHLIGHTS

The aquaculture cluster, which is steadily emerging, could become an important activity in Atlantic Canada. The cluster has excellent growth potential.

Existing product lines include:

- Atlantic Salmon;
- "Steelhead" Trout;
- cod;
- in-shore shellfish such as oysters and mussels;
- scallops;
- quahogs; and
- non-traditional fish species for Atlantic Canada, such as Arctic Char.

Backing these product lines is a tier of specialized support for aquaculture that extends across all of Atlantic Canada. This support includes:

- aquaculture planning;
- education, training;
- extension services to operators;
- potential future aquaculture development support;
- fish health systems;
- bio-technology support;
- feed for acquaculture cultivation; and
- physical equipment, such as cages, stocking and filters.

In turn, backing the product lines and the specialized support is a series of co-operative and publicly-available R&D capabilities, which include:

- aquaculture R&D at several stations;
- university research;
- bio-technology research;
- preservation and shelf-life research;
- fisheries aquaculture research;
- marine sciences; and
- technology transfer capabilities.

There is a broad range of related business support and related public support infrastructure in Atlantic Canada for aquaculture. All four provinces have explicit strategies and programs to support acquaculture development.

Aquaculture is an emerging cluster which offers good growth potential and the opportunity for significant local/regional linkages among firms and with the supporting technical and business infrastructure.

There are a number of distinct niche segments in the cluster (e.g. fin fish, shellfish, sea weeds). As well, the cluster has developed at different rates across the region; firstly in New Brunswick, then P.E.I., then Nova Scotia and then Newfoundland. If the region can successfully harvest species, such as flounder and cod, new market opportunities will follow.

There appears to be opportunities for cooperative ventures between aquaculture and food processing firms. This activity could be supported by the Food Technology Centre.

Some specific potential project developments for the cluster could include:

- joint marketing initiatives on the part of all of Atlantic Canada aquaculture producers;
- aquaculture as a source of bio-medicine;
- export of "growing systems" and brood stock ;
- cost containment research; and
- greater exploitation of evolving research knowledge.

Exhibit III-1 gives an overview of the Atlantic Canada aquaculture cluster. Exhibit III-2 presents the current development status of the aquaculture cluster against the eight ingredients of success. Issues related to the future development of the cluster include the development of a higher level of entrepreneurship, financing and the development of information networks.

Exhibit III-1 - Atlantic Canada Aquaculture Cluster

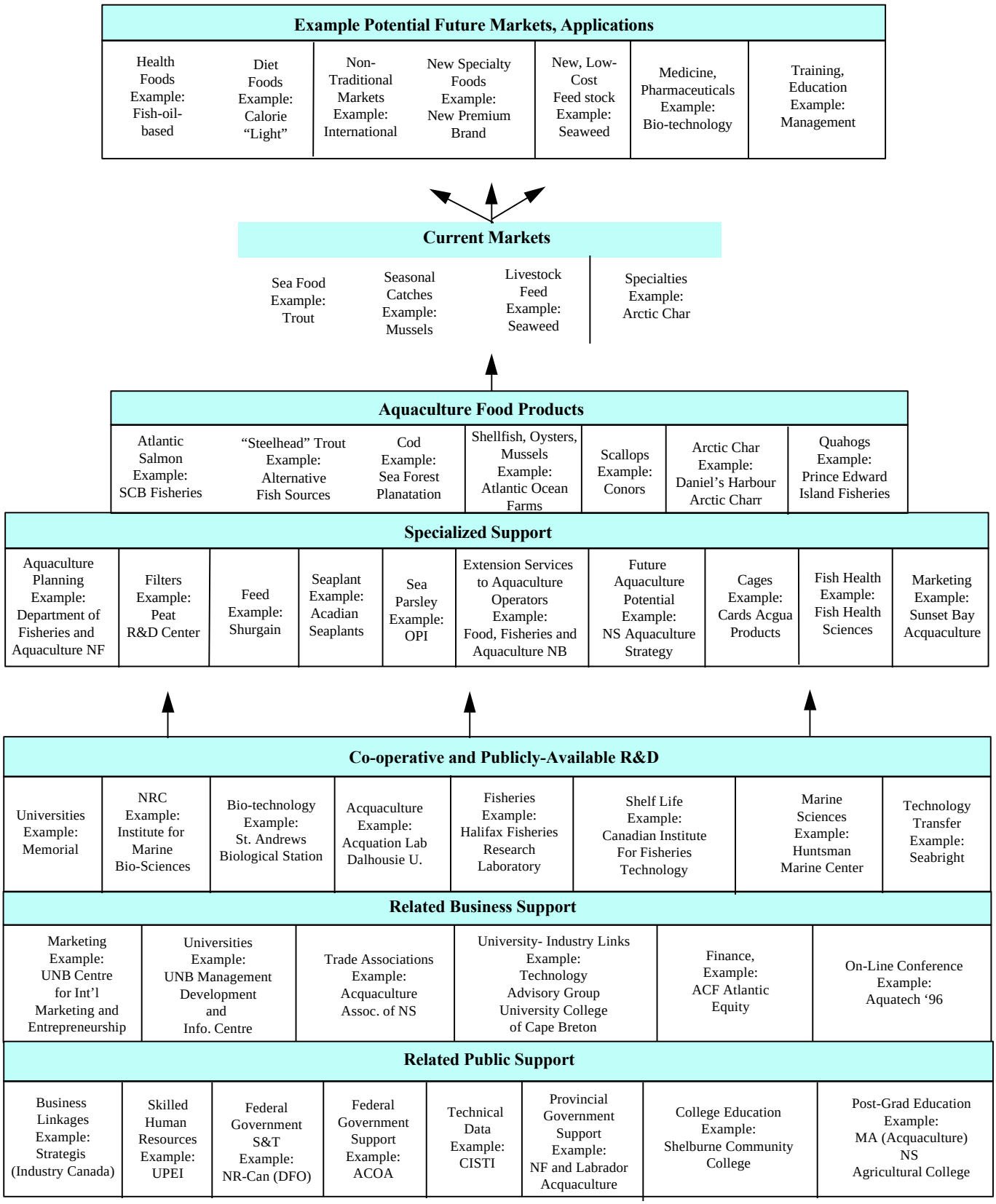
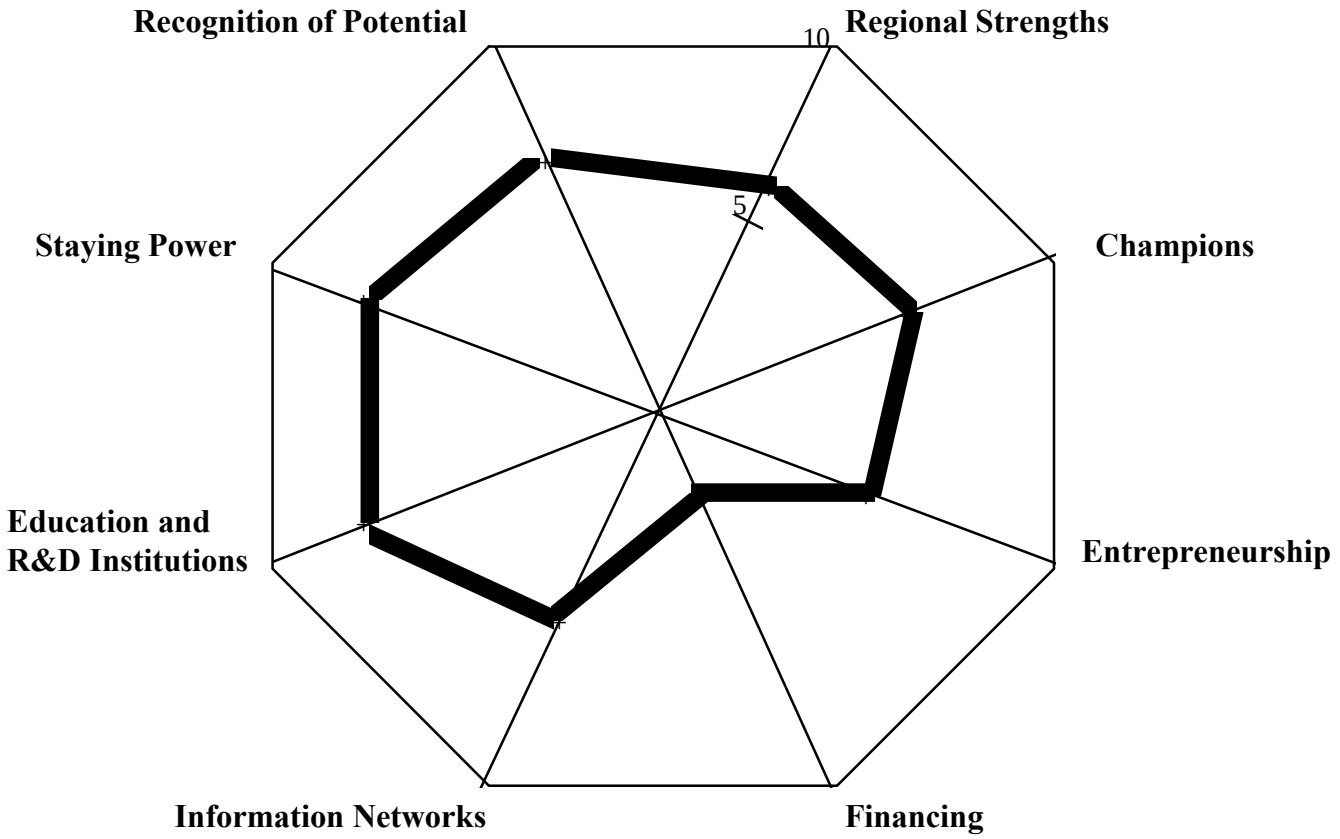


Exhibit III-2: Development Status of the Atlantic Canada Aquaculture Cluster



2.0
CLUSTER PROFILE

2.1 CURRENT MARKETS, APPLICATIONS

Aquaculture in Atlantic Canada cultivates many of the same sea food species and resources from "natural" fisheries. Moreover, there are some additional unique markets developed through aquaculture activities. These include:

Seafood

Salmon and other fish are being cultivated in specialized aquaculture habitats in Atlantic Canada;

Seasonal Catches

Some seasonal catches, for example, mussels and scallops are being cultivated virtually year round in Atlantic Canada aquaculture operations;

Livestock Feed

Seaweed is being cultivated in aquaculture for several purposes in Atlantic Canada, including specialized human consumption such as for Japanese Sushi, and as a livestock feed; and

Specialties

Arctic Char, not normally harvested in Atlantic Canada regions nevertheless is under cultivation through aquaculture.

2.2 POTENTIAL FUTURE MARKETS, APPLICATIONS

In the future, aquaculture could be applied to developing new markets for Atlantic Canada. These include:

Health Foods

Fish-oil-based products are frequently promoted as containing anti-oxident and anti-cancer agents. These characteristics could be further exploited.

Diet Foods

Traditionally fish has been well-regarded as a useful calorie-reduced component of human diets. This characteristic could conceivably be further exploited through selective product development and forceful marketing campaigns.

Non-traditional Markets

Aquaculture products could conceivably be developed to suit international markets, even if premium products were the principal output.

New Specialty Foods

Even in traditional markets, aquaculture could conceivably be exploited through association with specialized marketing, e.g. through new premium brands.

Low-cost Feedstocks

The market for aquaculture seaweed might be expanded to include low-cost livestock feedstock, to enhance diversification options in regional agriculture.

Medicines, Pharmaceuticals

The biotechnology research under way as part of the region's aquaculture cluster offers pharmaceutical potential.

Training, Education

Building on the region's well-known university and college resources, aquaculture could be turned into a new education specialty, particularly at the post-grad level, and for commercial management-oriented programs as well as more technical studies.

2.3 TOTAL VALUE OF CURRENT OUTPUT

Aquaculture production is expanding rapidly and currently represents approximately 25 percent of the total amount of seafood landings worldwide. Canada ranks 27th and accounts for 0.3 percent of world aquaculture production. Total output of Atlantic Canada commercial aquaculture was estimated by the federal Department of Fisheries and Oceans at $109.7 million in 1993. Of this total, $101.4 million was finfish and $8.3 million was shellfish. Moreover, for every commercial employee, there appears to be close to one supporting worker. Accordingly, to the $109.7 million sum would have to be added the value of the relevant supporting functions. Total value of output of the cluster would thus be approximately $200 million annually.

Moreover, these figures may even be conservative. The government of New Brunswick gives figures for aquaculture sales from fish farms based in that province alone as more than $100 million in 1994, and this is expected to rise to $200 million by 2000.

The Maritime provinces are well-placed with expertise in warmer-temperature aquaculture. Newfoundland is an ideal setting for cold water aquaculture development, possessing the right mix of abundant natural resources, technical expertise and research support.

2.4 ACQUACULTURE FOOD PRODUCTS

Current products include a wide range of outputs such as: Atlantic Salmon, "Steelhead" Trout, cod, quahogs, in-shore shellfish such as mussels and oysters, scallops, and non-traditional fish species for Atlantic Canada, such as Arctic Char.

2.4.1 Salmon and Trout

Atlantic salmon and rainbow (steelhead) trout are the two highest valued species currently farmed. The largest provincial producer is New Brunswick, whose 69 salmon farms yielded more than 12,000 tonnes of prime Atlantic salmon in 1994. An excellent example is Stott Sea Farms. About 75% of this harvest went to upside restaurants in the U.S. market. Trout farming is also under way in New Brunswick, building on the technical knowledge and viable infrastructure set up for Atlantic salmon acquaculture.

SCB Fisheries Limited, of Newfoundland, the largest of five salmon and trout operations in the Bay d'Espoir region currently employs between 70 and 80 people in its hatchery, grow-out facilities and processing plant. SCB markets its products to retail and food service customers across Canada and the Northeastern United States. Recent infrastructure improvements will enable the Company to double production levels this year.

2.4.2 Cod

Cod were first raised by Sea Forest Plantation Limited during the mid-1980s. Small cod caught in fish harvesters' nets were retained and grown to marketable size in captivity. Since that time, Sea Forest has focused its efforts on cod aquaculture training and the development and construction of a cod hatchery.

To date, about 320 fishery workers in Newfoundland communities have taken part in training delivered by the Company. Several of these participants are currently in the process of developing business plans and applying for aquaculture site licences.

As well, Sea Forest recently finished construction of North America's first commercial cod hatchery located in a former groundfish processing plant in Jerseyside, Placentia Bay. the hatchery is expected to produce 300,000 juvenile cod this year, with about half being sold to the

various cod farmers who took part in Sea Forest's training program. The remaining cod will be retained by the Company. Once in full production, the hatchery is expected to grow about two million juvenile cod and supply farmers year round.

2.4.3 Quahogs

Quahogs are an example of breeding research undertaken in Atlantic Canada for aquaculture purposes. A program is under way in Prince Edward Island, under the auspicies of the PEI Department of Agriculture, Fisheries and Forestry, which has been successful in spawning and raising seed in a hatchery. However, no consistent results have yet been obtained in raising this nursery stock to market size on leases. Attempts are under way through selective breeding to accelerate the natural typical 7-10 years required for growth to market size.

2.4.4 Blue Mussels

Blue mussels are currently the focus of the PEI aquaculture industry, production being valued at $8 million annually. As well, blue mussels are ideally suited for culture in Newfoundland waters. There are currently about 40 mussel farms in the Province. An important player in mussel farming is Atlantic Ocean Farms Limited of Notre Dame Bay. The Company employs 20 people directly, culturing, processing and marketing mussels. It augments its own supply by procuring mussels from other independent farmers. Mussels have been shipped by the Company since 1990, to domestic and mainland markets as far away as the southern United States. The Company is currently developing mussel aquaculture sites on the south cost of the Province, an area which holds enormous potential for the future.

2.4.5 Scallops

Giant scallop aquaculture received a much needed boost with the opening of a commercial hatchery in Belleoram, Newfoundland in July 1995. Until this opening, farmers had experienced problems in obtaining young scallops. The hatchery, employing technology developed and patented by the Ocean Sciences Centre at Memorial University of Newfoundland and Labrador, has the capacity to produce 20 million juvenile scallops a year. Already, about three million juvenile scallops have been produced, much of which will be used to supply the three scallop farms in the Provinces. Giant scallop aquaculture is also actively being developed in New Brunswick.

2.4.6 Arctic Char

Although not normally thought of as an Atlantic Canada fish, Arctic Char is under cultivation in the region. This is a case when the cold water specialization of Newfoundland's aquaculture has been exploited to raise fishstocks, but Arctic Char raising is also under way elsewhere in Atlantic Canada, most notably Nova Scotia.

2.4.7 Others

Many other species are under cultivation in Atlantic Canada, including crabs, warmer-water scallops and lobsters. In New Brunswick for example, aquaculture production has extended to include flounder, halibut and sea bass. Nova Scotia's range includes oysters and haddock as well as those species mentioned above. Prince Edward Island is focusing on novel shellfish species.

2.5 SPECIALIZED SUPPORT FOR AQUACULTURE

2.5.1 Acadian Seaplants Ltd.

Processing Atlantic Canadian seaweed into a range of biochemicals, as well as food and feed ingredients, is the function of Acadian Seaplants Limited (ASL). A technology-based manufacturing company, ASL operates six processing facilities in the Maritimes. Based in Dartmouth, N.S., ASL is North America's largest independent seaweed processing company and one of Canada's leading biotechnology firms.

Currently engaged in a number of technology development projects, ASL's partners in research include the Institute for Marine Biosciences of the National Research Council of Canada (IMB/NRCC), in NOVAcorp, the Technical University of Nova Scotia, the University of New Brunswick, Dalhousie University, and the Nova Scotia Agricultural College. Activities include:

- **Cultivation Research** - In collaboration with IMB/NRCC, ASL developed unique strains of seaweeds and cultivation technologies, as well as the world's only commercial inland seaweed cultivation facilities;

- **Seaweed Resource Management Science** - ASL's licensed Ascophyllum resource base is recognized as one of the best managed marine resources in Canada;

- **Product and Process Development** - All of the products manufactured by ASL have been developed in the Maritimes, employing "made in the Maritimes" technology and engineering expertise. ASL is continuously developing innovative applications for Maritime seaweeds, as well as the production processes and equipment required to manufacture products which meet the global market's rigorous demand for high quality, cost competitive goods; and

- **Product Applications Research** - Ongoing research into the performance benefits and applications of ASL products has been in place for several years. This research, which includes field trials on the use of ASL agricultural biochemicals, is conducted in actual user conditions throughout the world, in collaboration with private and university research institutions.

2.5.2 Aquaculture Planning

An example of support for aquaculture planning is provided by the Newfoundland Department of Fisheries and Aquaculture. The Department is providing more than $3 million in its 1996-97 budget to develop the province's aquaculture industry. Of the more than $3 million provided in this budget year, $2,396,000 is the funding under the aquaculture component of the federal-provincial Economic Renewal Agreement. An additional amount of about $820,000 is provided for aquaculture in the department's regular funding base.

Funding for the aquaculture component of the $100 million Economic Renewal Agreement is provided for initiatives in four principal areas: aquaculture planning, education in aquaculture technologies, research and development, and extension services to aquaculture operators.

Total aquaculture production in Newfoundland in 1995 was 1,023 tonnes, having a value of $3.7 million. Species under commercial cultivation in the province include Atlantic salmon, steelhead trout, mussels, scallop and arctic char. Research and development work has also been undertaken to determine the commercial potential of other species such as cod, yellowtail flounder, halibut and wolfish.

2.5.3 Peat Research and Development Centre

An unusual supporting element to the cluster is the Peat R&D Center in Shippagan, N.B. Although this is not directly R&D in support of aquaculture, the technology at the center assists the cluster nevertheless. An example of a relevant technology is filters.

A non-profit research organization, the Peat Research and Development Centre Inc. (PRDC) contributes to industrial development through research, consultation and analytical services.

- **Research** - The PRDC is well recognized for its leadership in a variety of research projects, including:
  - composting of peat with other organize wastes;
  - development of synthetic soils;
  - growth trials using a variety of growing media; and
  - biofiltration of waste waters.

- **Consultation** - A scientific information centre, the PRDC is recognized by the national Research Council Canada. Its library houses over 5,000 titles on peat, peatlands and related topics. In addition, it has access to numerous electronic databases. It offers:
  - support for quality control and quality assurance programs based on ISO standards;
  - technical support to the industry; and
  - organization and management of projects.

- **Services** - The PRDC offers services to natural resources-based industries such as mining, agriculture, fisheries and aquaculture, as well as environmental industries. It has a strong professional relationship with the industry, providing such services as:
  - analyses of peat, soils, fertilizers, composts, shellfish, ground water and waste water;
  - dust and noise level analysis in the workplace;
  - evaluation of the ecological impact from peat extraction activities;
  - evaluation (quantity and quality) of peat resources; and
  - design and monitoring of sedimentation ponds.

2.5.4 Extension Services

An example of extension services available to aquaculture is that of the New Brunswick Department of Food, Fisheries and Aquaculture. The objective of the Food, Fisheries & Aquaculture (FFA) Department is to assist the aquaculture sector by providing technical expertise in two main areas: fish health protection and value-added processing. In its fish health protection activities, FFA undertakes diagnosis and treatment technology development and disease screening of Atlantic Salmon, halibut, haddock and other fin fish species currently being considered for commercialization.

In its work with Atlantic Canada seafood companies, FFA has also focused on developing specialty, value-added products including utilization of Atlantic salmon and other aquacultured seafood.

2.5.5 Future Potential Aquaculture Development Support

An example of Atlantic Canada's support for future potential aquaculture development is Nova Scotia's Aquaculture Development Strategy. Other provinces equally have similar initiatives, but the Nova Scotia example well illustrates strategic support to the cluster.

The Nova Scotia strategy recognizes that aquaculture has yet to realize its full development potential in Nova Scotia. A coordinated effort of many stakeholders will be required. These stakeholders include the individual aquaculturist, the Aquaculture Association of Nova Scotia, and the departments and agencies of the federal and provincial governments.

To put forth a framework to guide the efforts of the Nova Scotia government toward the identified objectives, an Aquaculture Development Strategy has been prepared.

Each strategic initiative identified in the various components of the strategy represents many detailed projects and activities. Those projects and activities for the most part will not require resources additional to those already at hand. Aquaculture is a component of the Department of Fisheries Business Plan, and the strategy will be reflected in its annual work plans.

There are twelve components of the strategic plan for aquaculture development in Nova Scotia:

- research;
- technology development and transfer;
- education and training;
- resource allocation;
- environmental sustainability;
- fish health;
- access to financing;
- regulatory framework;
- communications;
- product quality and safety;
- marketing; and
- evaluation.

2.5.6 Fish Health

Several firms exist in Atlantic Canada in regard to acquaculture fish health. Examples include:

- Fish Health Sciences Inc. - developing diagnostics, treatments and disease preventing technologies for fish species;

- Diagnostic Chemicals Ltd. - a manufacturer of fine chemicals, enzymes and clinical chemistry reagents, Diagnostic Chemicals Limited (DCL) produces chemicals for use in various areas of the biomedical industry. DCL also works in the development of fish health products for use in the aquaculture industry;

  By employing bulk extraction processes, DCL purifies enzymes and other proteins. The firm produces clinical chemistry reagents for use in blood testing, using many of its own raw materials.

  At its modern, 28,000 sq. ft manufacturing facility located in Charlottetown, PEI, DCL is often contracted to develop manufacturing procedures as well as to produce the actual products. the plant houses 10/200 gallon glass-lined Pfaudler reactors and associated process equipment to manufacture large quantifies of highly purified chemicals. All manufacturing is carried out in an environmentally sound manner, utilizing a Thermal Combustion Oxidizer to eliminate residual organics.

  DCL is currently engaged in the development of various organic chemicals as well as additional diagnostic reagents. the company is involved in immuno-chemistry using its skills in the purification of proteins (antibodies). the aquaculture industry also presents new opportunities for DCL. Tests for oxytetracycline and other drugs used for disease

control in fish farming are under development by the firm. Current research also involves the development of immunoassay test kits for use in both human and animal diagnostics.

2.5.7 Feed

Specialized feed supplies exist in Atlantic Canada for acquaculture operations. One example is Shurgain Ltd. Other examples could be cited.

2.5.8 Sea Parsley

As a beginning initiative into developing sea parsley for feedstock and other purposes, OPI is active in cultivation of sea parsley.

2.5.9 Cages

Several local firms in Atlantic Canada are making physical cages and other hardware for acquaculture.

2.5.10 Marketing

A consortium, called Sunset Bay Aquaculture, consisting of five firms, provides international marketing support.

2.6 CO-OPERATIVE AND PUBLICLY-AVAILABLE R&D

Backing the tier of specialized support capabilities for aquaculture, Atlantic Canada has several collaborative and publicly-available R&D organizations. These include:

2.6.1 Huntsman Marine Science Centre

A research and teaching facility for eastern Canadian universities, Huntsman Marine Science Centre (HMSC) also counts a number of federal and provincial government departments in its membership. Located in St. Andrews, NB, adjacent to the Fisheries and Oceans Biological Station, the centre has developed considerable standing in fisheries aquaculture and environmental science. Almost half of its operating revenue is derived from contract research with industry and government, some of which originates outside Canada.

A major pillar of Huntsman's mission is science and technology transfer. Within its areas of expertise, it welcomes dialogue and initiatives related to contract assignments and partnerships.

Research includes:

- Christofor Research Lab houses 10 individual labs with salt/fresh water; two controlled-environment rooms; algal culture facilities; photomicroscopy room; walk-in cold room and freezer; 4,000 sq. ft. of space for fish and invertebrate holding; two freehouses provide an additional 5,000 sq. ft;

- Aquaculture Department - A centre for research, training, teaching and service to industry where the emphasis is on the development of alternate species for culture and testing of aquaculture products and systems;

- Atlantic Reference Centre houses a comprehensive reference collection of aquatic organisms providing a research and teaching resource and a biodiversity baseline, services and training in species identification, and ecological and environmental studies on aquatic ecosystems;

- Other facilities include research vessels, teaching labs, a dive centre, accommodation and meal facilities and a public aquarium.

2.6.2 Institute for Marine Biosciences

One of five National Research Council (NRC) laboratories, the Institute for Marine Biosciences (IMB) is committed to improving the economic performance of Canadian industry through biotechnology research. The focus at IMB is on marine biotechnology, with particular emphasis on programs which aid in the growth and diversification of Canada's aquaculture industry.

IMB's main laboratory is located on the campus of Dalhousie University in Halifax, NS, and includes facilities and equipment for mass spectrometry, nuclear magnetic resonance, electron microscopy, genomics/bioinformatics, natural products chemistry, microbiology and micro-algal research. It also operates an Aquaculture Research Station near Halifax on the Atlantic coast.

Facilities and Activities

- Aquaculture and Seafood Safety represents an important opportunity for sustainable economic growth in Canada's coastal communities. IMB's program is directed at broodstock development, hatchery operations, early life stages of new species, animal health and nutrition, and seafood safety. Research is aimed at facilitating the diversification and growth of the aquaculture sector, including fish, shellfish, marine plants, and the supply and service industry;

- In Marine Bioproducts, IMB works with industrial partners to isolate natural compounds from marine organisms for pharmaceutical, agrochemical or other desirable applications. Scientists can also determine chemical structures required for patent protection and use DNA sequencing and bioinformatics to provide clients with genes encoding useful products;

- The Marine Analytical Chemistry Standards Program (MACSP) enables IMB to develop analytical methods and provide certified standards and reference materials for trace elements and organic compounds, particularly seafood toxins and marine pollutants, in a variety of matrices. Products are used by analytical laboratories worldwide;

- Advanced mass spectrometry at IMB comprises a major component of its bioproducts, aquaculture research, and MACSP. IMB's internationally recognized expertise lies in the coupling of mass spectrometry to separation techniques such as gas, liquid, and supercritical fluid chromatographies, and capillary zone electrophoresis;

- Genomics/bioinformatics provides IMB with the unique capability (in Canada) to assist clients in accessing and effectively searching, analyzing and integrating information in international molecular biology databanks; and

- Networking - IMB is a gateway into NRC's national network of expertise, facilities and support for Canadian business. NRC includes the Canadian Institute for Science and Technical Information (CISTI), an unparalleled source of global scientific information, and the Industrial Research Assistance Program (IRAP), an important source of research funding for Canadian industry.

2.6.3 St. Andrews Biological Station

The St. Andrews Biological Station is a research facility within the Science Branch of Fisheries and Oceans Canada (DFO) Maritimes Region.

The St. Andrews Biological Station's physical plant includes: offices, laboratories, aquatic animal holding facilities equipped with seawater and freshwater, computer facilities, a library, and a wharf for research vessels. The main research activities are: aquaculture; stock assessments and related research on commercially important fin fish and invertebrates; aquatic environmental studies; and oceanographic research.

The Station's activities are conducted in collaboration with other DFO researchers and resource managers, government agencies, research and educational institutes, and the private sector.

- **Aquaculture Division** - Research is carried out to assist the existing salmon aquaculture industry of southwestern New Brunswick and on new candidate species, including halibut, haddock, striped bass, scallops, clams, and sea urchins;

- **Marine Fish Division** - The Gulf of Maine Section conducts assessments and associated research on: herring and groundfish (cod, haddock, pollock, flatfish) in the Bay of Fundy, Georges Bank, and Scotian Shelf; and on large pelagic fish (tuna and swordfish) along the Atlantic coast;

- **Invertebrate Fisheries Division** - The Gulf of Maine Fisheries Section conducts research on: lobster ecology; lobster growth and reproduction; assessments on Gulf of Maine crab species; and the development prospects for sea cucumbers;

- **Marine Environmental Sciences Division** - Research includes: effects of toxic chemicals in the marine environment; harmful algae and their effects; biochemical indicators of fish health; interactions between aquaculture and the environment; interactions between wild and cultured fish; effects of acid rain and its control programs on salmon and their habitat; and

- **Ocean Sciences Division** - The Station's coastal oceanography group examines the role of oceanography in fish distribution and the interactions between oceanography and acquaculture development.

2.6.4 Other Research

Other research units on acquaculture in Atlantic Canada include:

- Halifax Fisheries Research Laboratory;
- University research; and
- provincial government research.

2.7 RELATED BUSINESS SUPPORT

The base of related business support elements for acquaculture in Atlantic includes:

- the Canadian Acquaculture Institute;
- the Atlantic Salmon Federation;
- provincial acquaculture industry associations;
- marketing support through UNB's Center for International Marketing and Entrepreneurship;
- management support from the related UNB Management Development Center;

- University-industry links such as those of University College of Cape Breton;
- on-line conferences, such as Acquatech '96, supported by many firms and associations; and
- finance, venture capital such as that available from ACF Equity Atlantic.

2.8 RELATED PUBLIC SUPPORT

- business links through Industry Canada's "Strategis" intelligence service;
- federal government support such as Natural Resources Canada (Fisheries and Oceans);
- finance, venture capital from the Atlantic Canada Opportunities Agency (ACOA) - particularly vital in view of the limited access to "smart" financing small aquaculture firms inevitably face;
- technical data from the NRC's CISTI database;
- skilled human resources such as that provided by the University of PEI's fisheries graduates and post-graduate specialists such as those from the NS Agricultural College having an MA (Aquaculture) degree;
- technical graduates such as those from Shelborne Community College; and
- all four Atlantic Canada provinces have direct-support programs and strategies for aquaculture.

3.0
CLUSTER DYNAMICS

3.1 MARKETS

The largest market is for salmon. Other species in demand include steelhead trout, mussels, oysters, scallops, quahogs and arctic char. The industry is heavily reliant on international marketing because the local and Canadian markets cannot sustain the industry.

A high quality of products must be maintained as it is critical to marketing. Ongoing research into quality improvement is essential to the further development of the industry.

The industry needs to move to more value-added products. Once this happens there will be greater potential of cooperation between farmers and processors/producers (e.g. production equipment is very expensive).

Niche markets are also being developed, such as sea parsley for the Japanese sushi market. As well, the Food Technology Centre, in Charlottetown, in cooperation with Keeping and MacKay, has developed a process which simulates the natural adhering of herring roe to keep for export to Japan.

The development of feed that does not rely on hunt fish is a potential growth area.

3.2 LOCAL/REGIONAL LINKAGES

The linkages remain largely within the fin fish and shellfish industries respectively. There is not much synergy across these industry segments given the different requirements. There are also differences in local conditions; e.g. cold water aquaculture in Newfoundland versus warmer water aquaculture in New Brunswick. As well, much of the technology and equipment are developed outside the region.

Grand Isle Aquaculture Corp. of New Brunswick is a vertically integrated company with a marketing link to Maple Leaf Foods of Canada (i.e. a cross-cluster link to the food processing sector). This firm is also interacting closely with suppliers. For example, it has shifted from Norwegian suppliers of cages to local suppliers since they have modified their design to meet the requirements of Grand Isle. Another firm, Atlantic Aqua Farms, in PEI purchase mussels from seven growers, cleans and packages them for export to the Eastern U.S. and to Europe with a minor position for the Atlantic and Canadian markets.

Much of the equipment (e.g. floating equipment, rope, socking, buoys, boats, barges) and services (e.g. bacterial analysis) can be obtained in the region.

Interested organizations and firms come together as cooperatives (e.g. Sunset Bay Aquaculture) and associations for specific purposes. An example of the latter is the Bay of Fundy Salmon Marketing Institute formed by industry, government and universities to develop standards for the industry. The Institute has been successful in establishing standards that are recognized in the U.S.A. This supports marketing in the U.S.A. Each province also has its respective industry association.

The firms are also linked to government and university research institutes in the region for technical support.

Aquaculture is a young cluster which is developing a network of informal and formal linkages regionally. There is an expectation that conglomerates will emerge and this is not necessarily seen in a positive light.

3.3 EXTERNAL LINKAGES

Most external linkages are centered on marketing. Many firms use associates or firms in the USA and Europe to market their products there.

There are also technical links to the Scandinavian aquaculture industry which is more mature. There has been technology transferred from the Scandinavian industry which was very supportive in the early stages of development of the industry in Atlantic Canada.

The Canadian Aquaculture Institute seeks a world-wide market for its training programs. The Institute has recently signed an agreement to provide training in Malaysia. Course leaders are recruited from within and outside the region.

3.4 INFRASTRUCTURE

3.4.1 Technical Support

Training support is available throughout the region (e.g. NS Agricultural College, UNB, Huntsman Marine, Holland College, Memorial, etc.).

As well, there is a wide range of technical and R&D support through the various government (federal/provincial) and university research groups in the region. The industry is reliant on this support.

Also, the industry relies on veterinarian (disease control, animal health and nutrition) and inspection (quality control and detoxification assurance) services from government.

3.4.2 Business Support

Various provincial and national industry associations promote the industry and assist in international marketing (e.g. participation in trade shows and missions).

ACOA has played an important role in the early stages of the development of firms. Other financial instruments include the Farmers Credit Cooperative as well as capital from parent firms (e.g. Sambro) and partners (e.g. Maple Leaf and Grand Isle).

3.5 SUMMING UP

Aquaculture is an emerging cluster which offers good growth potential and the opportunity for significant local/regional linkages among firms and with the supporting technical and business infrastructure.

There are a number of distinct niche segments in the cluster (e.g. fin fish, shellfish, sea weeds). As well, the cluster has developed at different rates across the region; firstly in N.B., then P.E.I., then N.S. and then Nfld. If the region can successfully harvest species, such as flounder and cod, new market opportunities will follow.

There appears to be opportunities for cooperative ventures between aquaculture and food processing firms. This activity could be supported by the Food Technology Centre.

4.0
ISSUES IN CLUSTER DEVELOPMENT

4.1 CLUSTER STRATEGY

While falling under one generic rubric, aquaculture is highly differentiated in terms of niche segments and geographic potential (i.e. cold versus warm waters). Nevertheless the evidence suggests that it could become an important activity in Atlantic Canada, and that even if nascent, the cluster has excellent growth potential.

There is also the opportunity to market the R&D work done in the sector, particularly in the area of aquaculture health services.

4.2 ISSUES

Issues related to cluster development include:

- weakness in marketing;
- staying abreast of technological developments;
- financial support for the early stage of firm development;
- continued government technical support in the face of budgetary constraints;
- maximizing the local supplier-producer linkages.

4.3 POTENTIAL PROJECTS

Some specific potential project developments for the cluster could include:

- joint marketing initiatives on the part of all of Atlantic Canada aquaculture producers;
- aquaculture as a source of bio-medicine;
- export of “growing systems” and brood stock ;
- cost containment research; and
- greater exploitation of evolving research knowledge.

SECTION 2
SUB-REGIONAL CLUSTERS

IV - NEWFOUNDLAND AND LABRADOR OCEANS TECHNOLOGY CLUSTER

V - NOVA SCOTIA MEDICAL DEVICES AND SERVICES CLUSTER

VI - NB/PEI FOOD PROCESSING CLUSTER

IV THE NEWFOUNDLAND AND LABRADOR OCEANS TECHNOLOGY AND MARINE COMMUNICATIONS CLUSTER

1.0 HIGHLIGHTS

The Newfoundland and Labrador Oceans Technology and Marine Communications cluster is technologically sophisticated, and backed up by a technical infrastructure that features excellent government-firm linkages. Limiting factors include the small number and size of the commercial firms, the lack of focus in the sense that the cluster lacks a larger unit providing an integration role – i.e., a firm, or other organization, that could expand and enhance the cluster's saleable products and services. However, there is evidence that such an integrating role would be possible for some of the organizations in the cluster, both on the oceans technology grouping and on the marine communications grouping; in fact, such developments are under way.

Current markets for the cluster are mainly resource extraction and exploitation, most notably fisheries and off-shore oil exploration, with some opportunities in related marine transportation. Future markets could be much broader. They might include coastal zone management, weather forecasting and climatology including environmental control, sea-bed exploration and mining, training and education, and new business platforms that involved oceans.

The current cluster profile shows significant technological strengths, although most of it is in small firms and organizations in niche markets.

Current oceans-related and marine communications equipment and products provided by the cluster include:

- acoustic sensors and underwater telemetry;
- surveillance;
- ground-wave radar remote scanning;
- underwater products;
- underwater construction;
- specialized marine communications systems; and
- evacuation and rescue systems.

Backing this first tier of equipment and products is a second tier of specialized service providers. These include:

- sub-sea engineering;
- software development;
- marine engineering;

- environmental modelling and forecasting;
- ocean mapping;
- maintenance and repair;
- project management; and
- informatics services.

Another tier of co-operative and publicly-available R&D resources also backs the equipment and products and services tiers. This tier includes some particularly important players in the cluster who might become candidates for a larger future role. These include:

- the Institute for Marine Dynamics;
- C-CORE;
- Memorial University;
- technology transfer units such as Seabright;
- the National Research Council (NRC); and
- the Canadian Center for Marine Communications (CCMC).

There is also a network of related business support units ranging from information systems management to finance and venture capital groups, and another network of related public support units.

However, the total value of output of the cluster is small, estimated at a maximum of $100 million annually. Total commercial sales (not counting the value of the supporting units) is estimated at $31 million annually. Keeping continuous markets has been a problem in the past.

The cluster dynamics reflect the behaviour of small individualist firms in an emerging technological domain operating far from major markets.

Some firms with complementary capabilities have been working together, along with research organizations. More projects that bring firms together are needed to develop critical mass and credibility as well as to overcome the resistance of working in alliances to reach international markets.

Issues in the future development of this cluster include:

- ensuring continuity of marketing and internal development of the cluster ;
- developing broad-based oceans technology and marine communications capabilities that would be applicable not just in North Atlantic or even cold water environments but globally;
- explicitly capitalizing on new opportunities both in Canadian areas and overseas;
- obtaining international market intelligence;
- developing international marketing skills;

- addressing the lack of venture capital; and
- developing projects (e.g. product development, R&D, marketing) that bring together firms and research organizations with complementary capabilities. Working together can provide critical mass and overcome suspicion.

Some specific potential project developments for the cluster could be:

- environmental projects;
- oil and gas projects;
- aquaculture projects;
- co-operative geomatics projects;
- seabed and other mining/exploration projects; and
- integrated traffic management projects.

Exhibit IV-1 gives an overview of the Newfoundland and Labrador Oceans Technology and Marine Communications cluster.

Exhibit IV-2 presents the current development status of the oceans technology cluster against the eight ingredients of success. It is a cluster driven by its base in educational/R&D institutions but which lacks much of the private sector elements needed to develop fully.

Exhibit IV-1: Newfoundland and Labrador Oceans Technology and Marine Communications Cluster

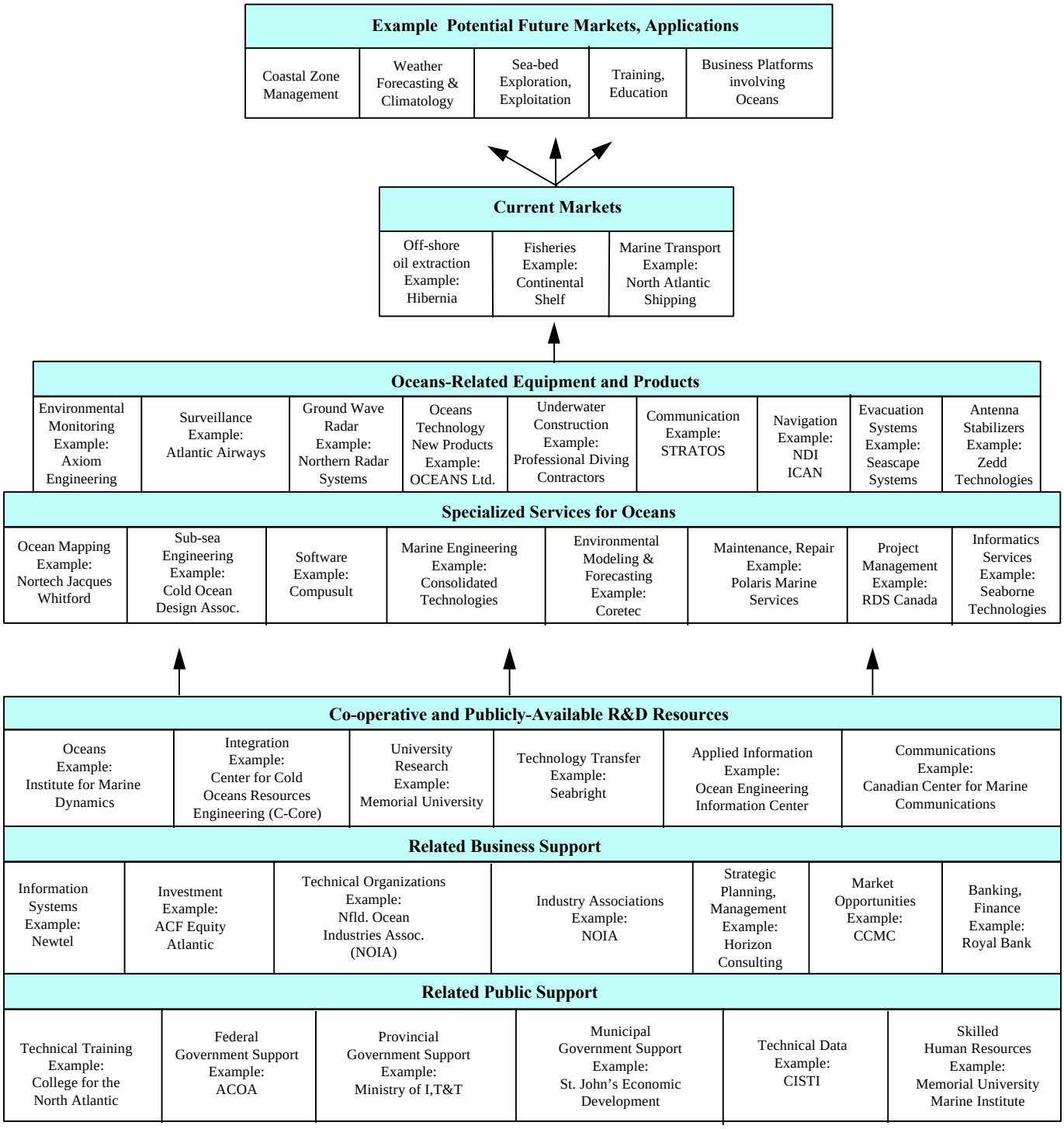
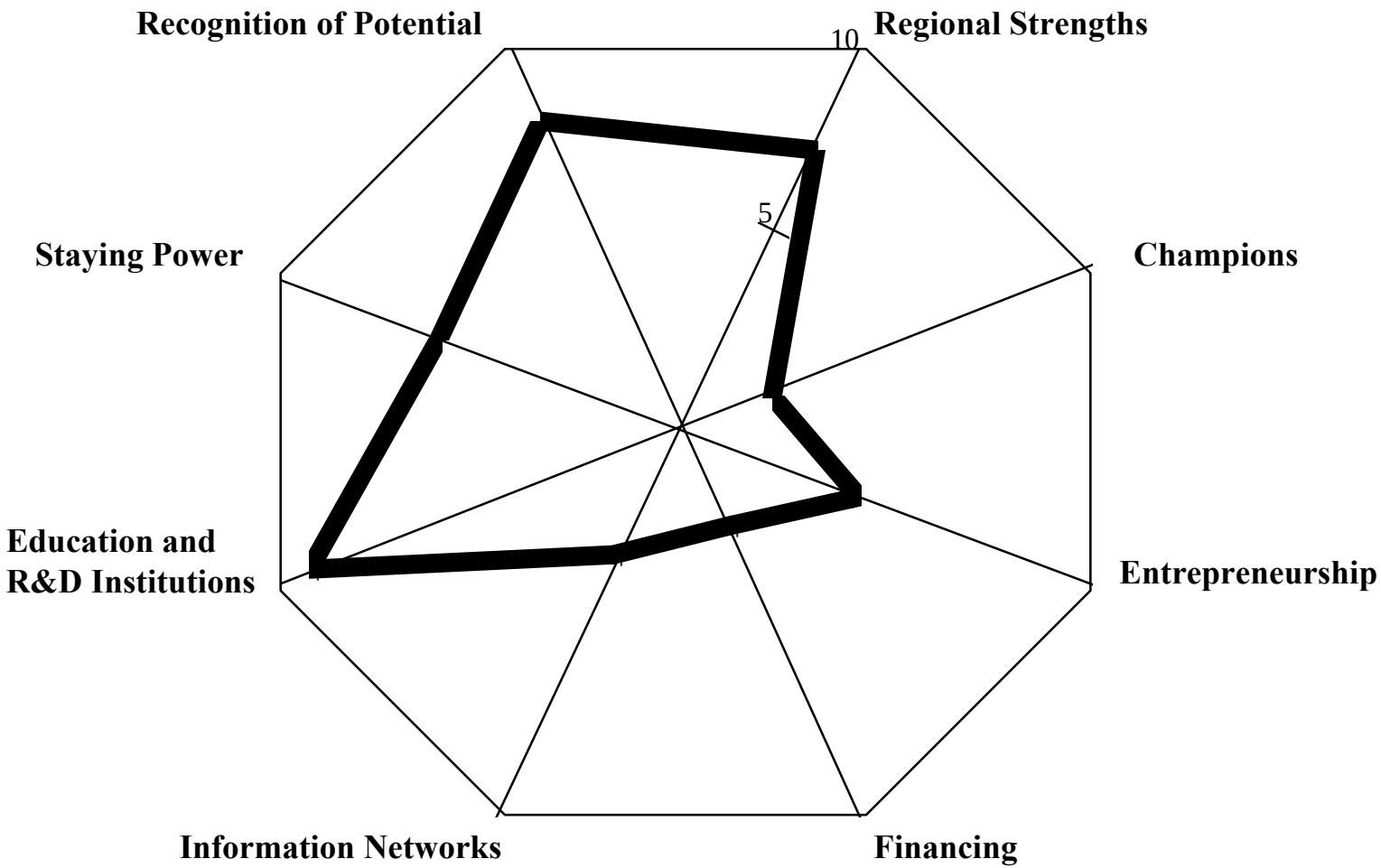


Exhibit IV-2: Development Status of the Newfoundland Ocean Technology Cluster



2.0 CLUSTER PROFILE

2.1 CURRENT MARKETS, APPLICATIONS

The current major markets and applications for the cluster are:

Off-shore Oil Extraction

Several billion barrels of oil are believed to exist beneath the continental shelf fairly close to Newfoundland shores. This prospect should be put in proportion: Canada's entire current inventory of proven crude oil reserves is approximately 6 billion barrels, mostly in Western Canada. However, oil extracted from under the sea typically carries high costs in terms of oil derrick and platform construction, oil well development, extraction (drilling) and transport to pipeline networks. In the case of Newfoundland these costs are exacerbated by the even more difficult than normal North Atlantic location. Moreover, oil production has not yet begun although numerous exploratory and test wells have been established. The "Hibernia" project involves a total investment of close to $2.5 billion to extract oil from the Newfoundland off-shore location; it is the leading extraction project at present. Others are being developed.

The severe environment in which oil extraction off Newfoundland takes place has provided opportunities for the cluster. Moreover, the technical excellence of the cluster's organizations is enhanced through the "most-demanding" nature of the local work. This actually stands the cluster in good technical stead.

In the years to come, other severe environment resource extraction, principally oil, could very well exist. There has been much speculation about oil off the shores of the Falkland Islands – sufficiently southerly to parallel the North Atlantic's gales and icebergs. There could well be long-term market opportunities.

Fisheries

The most significant market for the oceans technology and marine communications cluster has been in fisheries. The North Atlantic has long been known for its huge fish resources – albeit with some considerable interruptions in the last three years. This market will also likely continue in the long term, although the short term remains more problematical owing to depletion of fish stocks in the region.

Marine Transport

The North Atlantic route remains the most dangerous and difficult shipping route in the world yet carries a higher volume of traffic than almost any other. Oceans technology and marine communications are obviously vital to this sea lane. the "most demanding customer" character of these requirements are promising for the cluster.

2.2 NEW OPPORTUNITIES

Existing research and published literature has identified a number of potential new opportunities for the cluster that represent new markets and applications for the cluster.

However, these new opportunities should be understood to be only examples – others may emerge from the cluster's own development and possibly some of these illustrations will not ever materialize. Nevertheless, they show that considerable innovation opportunities do exist.

Coastal Zone Management

Newfoundland and Labrador, by virtue of its location, inevitably participates in the new, emerging activities relating to coastal zones. For example, parallel to weather forecasting and climatology is environmental control. Obvious candidates for the cluster include oil spill control and iceberg monitoring. Other such activities include:

- shipping lane management;
- resource demarcation;
- resource exploitation;
- safety and security;
- search and rescue;
- environmental response and control (e.g., fog, icebergs); and
- many others.

Weather Forecasting and Climatology

Weather and climate are inevitably a prime concern to coastal zones such as Newfoundland and Labrador. Moreover this is especially relevant to this cluster, with its existing and future off-shore resource exploitation orientation. Recent issues such as global warming have highlighted the significance of this issue.

Sea-bed Mining, Exploration

The recent great interest in marine "archeology" and marine science – exemplified by the search for the remains of the battleship Bismarck and the Titanic liner – in conjunction with concern for the future of large underwater structures such as Australia's coral Great Barrier Reef, suggest there may be many future opportunities in non-traditional underwater exploration. Sea-bed mining has remained purely speculative, but may become important one day.

Training, Education

Parallel to the recent upsurge in marine exploration, there may be a future market in marine education and underwater training. The cluster's particularly well positioned to meet this need, in light of the variety of specialties, and range of applications.

Business Platforms

Perhaps the most important potential market would be business platforms that could incorporate oceans technologies and marine communications to enhance their operational capabilities. Examples might be fishing fleet management and on-board processing.

2.3 VALUE OF OUTPUT

The total value of output of the cluster is small, estimated at a maximum of $100 million annually. Of this total sum, the annual commercial sales of the cluster (i.e. subtracting the value of public R&D and the various business and public support units) is estimated at $31 million annually.

This figure of $100 million is essentially derived from the relatively small size of the firms and organizations in the cluster. Very few of the cluster's units have annual revenues above $5 million. (The figure is limited to the cluster itself only, and does not include, for example, the total budget of area educational/training establishments, on-going fisheries or oil exploration work, transportation companies' revenues, etc.).

2.4 OCEANS-RELATED EQUIPMENT AND PRODUCTS

The cluster currently produces a wide range of products and services, mostly from a collection of interesting small firms operating in niche specialties for local markets.

Only a few illustrations can be given here, but they serve to show the breadth of the cluster's capabilities.

Axiom Engineering Ltd.

Axiom designs and manufactures oil spill cleanup equipment, environmental monitoring systems and provides engineering design support for research, development and prototyping. The firm possesses a broad spectrum of professional experience in product development and utilizes the latest computer-aided design tools. The facility is well equipped with a full complement of precision machining, fabrication and metal working equipment. Axiom provides design and fabrication of specialized prototype systems for use in both scientific research and industrial applications. Engineering design services include:

1. mechanical and electronics system design;
2. precision machining and manufacturing;
3. oil spill response technologies; and
4. environmental instrumentation.

Canpolar East

Canpolar East Inc. is a Canadian Engineering company specializing in industrial sensors and process automation equipment. Canpolar East designs and delivers turnkey systems, machinery and software. It also provides technical feasibility studies and custom designs. The company has extensive experience with fish and food processing automation. In addition, it serves industrial and government markets in the development and delivery of surveillance systems and space hardware.

INSTRUMAR Ltd.

Founded in 1980, INSTRUMAR Limited is an engineering company that specializes in the design and manufacture of contact and close proximity sensor systems for the aviation, aerospace, and oil and gas industries, Its activities include:

- an electronic, electrical and mechanical engineering consulting firm;
- an instrumentation design corporation specializing in intelligent sensor systems;
- a systems integration organization;
- a developer of specialized software;
- an extensive user of analytical-based design tools;

- a designer/manufacturer of printed circuit boards;
- an assembler of electronic/electro mechanical devices; and
- committed to Total Quality Management.

Lotek Marine Technologies

Lotek Marine Technologies Inc. provides a range of technical products and services to the wildlife and fisheries research and natural resource management communities. Products include: acoustic and radio transmitters for most sizes of marine animals ranging from smelt to sea turtles; field-rugged receivers for acquiring and logging transmitted information such as time, depth, position, temperature and animal energetics; GPS satellite based location capabilities; engineering services for the development of marine wildlife applications.

Northern Radar Systems

The company has developed a state of the art High Frequency Ground Wave Radar (GWR) System. Each GWR system provides surveillance on a 24-hour, daily, all around the year basis. It can monitor over 225,000 km for tracking icebergs, sea ice, surface currents, ships, aircrafts, surface wind, and waves and sea state measurements.

OCEANS Ltd.

Formed in 1981, Oceans Limited has developed an expert multi-disciplinary staff with skills in meteorology, physical oceanography, software and instrumentation development, biotechnology (kelp, groundfish and shellfish), marine engineering and the design and manufacture of navigational aids (buoys). Oceans Limited has developed the most advanced private weather and seastate forecasting service available, as well as innovative environmental bio-monitoring methodologies using fish health indicators in the fields of toxicology, histopathology, biochemistry, and enzyme analysis.

Guigné International Ltd.

A design engineering firm and original equipment manufacturer, Guigné International Ltd. (GIL) was established in 1989 in Paradise, Newfoundland, to advance innovative designs in underwater acoustics, adaptive signal/information processing and acoustic levitation engineering. It combines industrial design and physics from scientists and engineering. It combines industrial design and physics from scientists and engineering. who have established international experience and research backgrounds in acoustics, computer engineering, mathematics and marine ecology. GIL's research is directed at problems where acoustics are central to the solutions. The company creates smart acoustical systems involving nonlinear acoustic principles, parallel processing, chaos modelling and high speed fuzzy logic controllers. The objective of GIL's research is to engineer devices which possess unparalleled imaging abilities with auto functions. Guigné International Ltd. provides exceptional research

support for those interested in applying acoustics to industrial-related problems. Guigné's sonar technology, called DRUMS™ (Dynamically Responding Underwater Matrix Sonar), is central to all GIL's acoustics designs and its line of sonar products, including its acoustic software Sonique™. Developed in Newfoundland, DRUMS™ has been gaining acceptance within the international scientific community as a promising and commercially viable technology for solving engineering problems.

Stratos Mobile Limited.

Stratos Mobile Ltd. (formerly NewEast Wireless Technologies Ltd.) is a vertically integrated communications company in business for over 10 years. Through its subsidiaries, NewEast Wireless Telecom Ltd. and Ultimateast Data Communications, the Company markets wireless communications services throughout the world utilizing both satellite and high frequency (HF) technology. It serves customers in government, mining, fishing, marine and transport markets.

The Company had its beginning doing wireless telecommunications work for the Newfoundland fishing industry. It went to grow substantially and develop several niche markets, particularly in data communications and fleet management. Its systems can be used in conjunction with private HF networks, as well as satellite networks such as MSAT and Inmarsat.

Others

Strictly as illustrations, other examples of innovative oceans technology and marine communications equipment and products suppliers include:

- Seascape Ltd. – evacuation systems, rescue gear;
- Atlantic Airways – maritime surveillance;
- Professional Diving Contractors – underwater construction, marine engineering; and
- Zedd Technologies - antenna stabilizers.

2.5 SPECIALIZED SERVICES FOR OCEANS

Backing the specialized equipment and products are on equally wide range of specialized oceans services. Only a brief summary can be given here, and many others could again be cited. They include:

- Cold Ocean Design Associates – sub-sea engineering, design;
- Compusult – software engineering, computer consulting; systems integration; data communications technologies; database design and development; data warehousing; environmental monitoring; data acquisition, analysis and management GIS; and internet services;
- Consolidated Technologies – shipboard electronics and networking;
- CORETEC Inc. – applied research and development, services in the areas of offshore and environmental engineering, marine hydrodynamics, and information technology. This company provides R&D and consulting services to local, national and international clients, drawing expertise from wide-ranging skills and experience of a team of engineers, naval architects, scientists, and software designers;
- Polaris Marine Services – underwater and marine maintenance, repair and equipment support;
- RDS Canada – project management, management support and scheduling;
- Technologies Ltd. – professional EDP and marine environmental science consulting and services. Seaborne currently employs 25 computer specialists, engineers, and scientists. Technically, the company presents a wide spectrum of integrated, complementary capabilities and experience including: management information systems, custom scientific and general computing applications, software products for the marine environmental sector, and computer systems and EDI support services. The company has extensive software sales and project experience throughout Canada and overseas.
- Stratos Mobile Ltd. – international long range satellite and radio carrier, providing mobile communications as sea, on land and in the air. As a part of the worldwide TeleOceanics brand name, NewEast supplies the world's most powerful satellite systems, operates Canada's largest commercial HF coastal station providing marine and aeronautical communications service in the North Atlantic via its call signs Rainbow Radio, Tors Cove Radio.

2.6 CO-OPERATIVE AND PUBLICLY-AVAILABLE R&D RESOURCES

The cluster has great strengths in terms of available R&D and R&D management, including applications and technology transfer. Some important elements of this tier of R&D capabilities are among the most advanced in the world, and these capabilities are worth noting in detail. They include:

2.6.1 NRC/Institute for Marine Dynamics

A branch of the National Research Council, the Institute for Marine Dynamics (IMD) was established in St. John's, Newfoundland, in 1985, as Canada's primary centre for ocean technology research and development. Its mission is to provide innovative solutions and technical expertise in engineering related to the world's oceans. It collaborates with industry, government and universities to anticipate and respond to challenges and opportunities in areas of ocean technology. The Institute is positioned to address the needs of a wide range of enterprises and has the ability to assist multi-nationals or small ventures and consultants. IMD also works with foreign firms and research organizations and acts as a conduit for international technology to Canada. The Institute includes:

- The Marine Systems Group addresses the requirements of the ship design and shipping industries, including research on advanced navigation capabilities based on electronic chart systems. It also conducts research to prevent capsizing of fishing vessels and ferries, and studies the safe limits for ice forces on the propulsion systems of ice breakers;

- The Offshore Engineering Group works with domestic and international offshore industries in assisting the development of a Canadian offshore capability. The immediate thrust is developing cost-effective offshore production concepts affected by ice and extreme wave conditions in the Canadian environment; and

- The Advanced Project Group assists domestic ocean technology companies with their R&D requirements..

The extensive facilities include:

- the **Offshore Engineering Basin**, capable of modelling virtually any ocean state by means of its 168 computer-controlled wavemakers. The basin measures 75 X 32 metres and can produce regular, irregular and multi-directional short-crested waves to model full-scale seas. The 200-metre **Towing Tank** provides data on resistance, propulsion, wake surveys, flow visualization and other vessel investigations. Two pieces of equipment augment the tank's capabilities: a **yacht dynamometer**, developed for America's Cup research and a **Marine Dynamic Test Facility**, the only device in existence capable of evaluating underwater vehicles in six degrees of freedom of motion. The 90-metre **Ice Tank** is the

world's longest, with a custom towing carriage from which models are towed or otherwise controlled. On-board computers provide data collection and reduction, while video cameras record the ice-model interaction both above and below the waterline.

2.6.2 C-CORE

C-CORE is an independently-funded research and development institute of Memorial University. It is located on the campus of Memorial University, and there is close interaction with various academic units within the University, including the faculties of Engineering and Applied Science, Science and Business Administration.

C-CORE was initially set up to carry out collaborative research and development toward the responsible exploitation of our ocean resources, and until recently the research groups included ice engineering, remote sensing, and seabed geophysics. Recently, however, C-CORE has broadened its application areas to include terrestrial and space problems through the activities of new research groups in geotechnical engineering, space systems and intelligent systems. C-CORE is committed to transferring technology to the private sector through strategic alliances and cooperative programs.

The R&D programs at C-CORE are primarily conducted in collaboration with industry. Collaborative R&D is driven by rapid technological change, the growth of interdisciplinary research, the need for highly qualified persons, globalization of markets, the application of information technology, stewardship of the environment, infrastructure costs, and the cost of large projects. Benefits of collaborative R&D include cost sharing, intellectual resource sharing, logistic sharing, and increased market opportunities.

Major research thrusts have evolved to deal with engineering and scientific issues;

- Ice Engineering;
- Remote Sensing;
- Seabed Geophysics;
- Geotechnical Engineering;
- Space Systems and Applications; and
- Intelligent Systems and Advanced Materials.

C-CORE's researchers have backgrounds in engineering, physics, geophysics, geology, geography, oceanography, mathematics and computer science. This critical mass of expertise is enhanced through the Centre's collaborative partnerships with industrial, government and academic sectors. The Centre's expertise encompasses:

- ice engineering and physics;
- structural engineering;
- risk analysis;
- environmental engineering;

- geotechnical engineering;
- instrumentation design;
- hydrodynamics;
- HF and microwave radar;
- geographical information systems;
- antenna design;
- materials science;
- marine mining and geology;
- centrifuge modelling;
- control systems engineering;
- microgravity;
- industrial automation;
- pattern recognition;
- computer vision;
- intelligent systems; and
- robotics.

To give an illustration of C-CORE's depth, the Ice Engineering Research program is highly significant. Sea ice and icebergs in cold oceans influence the design and operation of any ocean facility or activity. The management of ice in its many forms is required for safe and cost effective offshore exploration and development. With growing knowledge of the ice environment, engineering systems are being developed to undertake safe and economic recovery of resources.

The ice engineering program is carried out in close collaboration with industry and government. The major emphasis of the work is the determination of full scale ice properties measured in the field and their application for design of systems. There are three broad categories of research:

- Ice Structure Interaction
  - ice design characteristics for offshore systems;
  - dynamic behaviour of structures;
  - bergy bit and iceberg motions and impact dynamics;
  - probabilistic, analytical, and finite element modelling; and
  - bergy bit striking a load panel.

- Ice Dynamics
  - environmental effects on ice movement; and
  - forces exerted by icebergs and pressure ridges on the seabed.

- Ice Forecasting
  - operational sea ice edge and iceberg forecasting;
  - computer systems to manage sea ice and iceberg information; and
  - bergy bit and growler populations.

The transfer of ice related technology for commercial applications is another major initiative of the group. Through the formation of a Newfoundland based company, Cold Oceans Design Associates (CODA), ice engineering technology is being transferred to the marketplace. This is combined with subsea pipeline technology developed in the United Kingdom. The ice forecasting system is licensed to another Newfoundland company, CORETEC Incorporated, for commercial use.

The Ice Engineering group is involved in a number of collaborative projects. Clients are from government and industry in Canada, the United States, and Europe. A series of successful field programs to measure loads and pressures resulting from bergy bit impacts against a structure led to a major international project with partners from a number of countries.

The research team has also developed a teaming agreement with the ice group at the Institute for Marine Dynamics. The objective of the teaming agreement is to market ice expertise on an international basis.

Similarly, the Intelligent Systems Research program works in areas such as robotics, automation, computer vision and acoustic sensing which C-CORE and its industrial partners could draw upon. The group has also expanded its expertise to include advanced materials.

Activities currently being undertaken by this group include:

- Computer Vision Applications
  - development of algorithms for accurate detection of parasites in fish;
  - development of analytical techniques for taxonomic identification of acoustic signals;
  - reconstruction of mud volcano flow patterns; and
  - kinesthetic textiles.

- Automation Applications
  - identification of opportunities for technological innovation in crab/capelin industry;
  - improved methods for crab leg curing;
  - intelligent sensors for space applications;
  - telerobotic systems for mining automation; and
  - robotic inspection of underground storage tanks.

- Advanced Technologies
  - development of high-damping composite structural components; and
  - multi-phase flow metering.

- Marine Robotics and Subsea Systems
  - 3D underwater machine vision;

- ice monitoring and measurement;
- fish stock assessment and monitoring; and
- development of a seabed crawler.

The other programs at C-CORE are equally significant and impressive. Space presents more detailed description.

2.6.3 Memorial University

One of the most important research facilities in the Atlantic region, and the largest university east of Montreal, Memorial University of Newfoundland has taken advantage of its maritime location to develop world class expertise in almost all aspects of ocean and fisheries-related research.

Facilities and Activities

- The **Ocean Engineering Research Centre** (OERC) boasts expertise in a range of disciplines, from marine hydrodynamics to naval architectural aspects including vessel motions, propulsion and small craft problems;

- The **Ocean Sciences Centre** (OSC) facilitates research on seasonal phenomena such as control of reproductive cycles and synthesis of antifreeze proteins and variation in fish behaviour;

- The **Centre for Earth Resources Research** (CERR) promotes collaboration with industry and government agencies interested in mineral and petroleum resources and environmental issues;

- The **Centre for Marine Simulation** (CMS) represents the world's latest development in marine simulation with full-motion bridge and ballast control/cargo operations and engine room simulators; and

- The **Canadian Centre for Fisheries Innovation** (CCFI) has been mandated to apply the fisheries related science and technology capability of Memorial University and the Fisheries and Marine Institute of Memorial University to the problems and potential of the fishing industry.

2.6.4 Seabright Corp. Ltd.

Established by Memorial University of Newfoundland in 1987, Seabright Corporation Limited's mission is technology transfer – to increase the economic benefits to the province of Newfoundland and Labrador from research and development conducted at the university. Since its inception, Seabright has endeavored to create new industries in the province, and to help Memorial University respond to the technological and scientific needs of industry through the practical application of its scientific and technological research.

Privately owned by memorial University, Seabright Corporation Limited is governed by a Board of directors representing industry, academia, and government. As a not-for-profit organization, Seabright focuses on new technologies, processes, services and products which enhance, improve and/or diversify an existing industry's capability, and on the creation of new industries which do not compete with those already in existence in the private sector. Seabright's mandate includes:

- **Intellectual Property Management**, which involves evaluation, procurement and funding of patents, trademarks and copyrights;
- **development and management of spin-off companies**, strategic alliances, and licensing agreements;
- providing **industry access** to the University's expertise and facilities; and
- providing an **information network**.

2.6.5 Ocean Engineering Information Centre (OEIC)

OEIC's principal role is to provide an information search service in cold ocean engineering. The service is available to industry and government groups under specific contract arrangements. A major client is C-CORE.

OEIC's services include:

- computer searches;
- interlibrary loans from outside the province;
- retrieval of material from OEIC and/or other Newfoundland libraries;
- assistance in locating "hard to find" references and obscure documents; and
- identification of current research in progress.

A special collection of material relating to ocean engineering and offshore resource development in cold waters has been built up to support the information search service. Subjects include:

- sea ice;
- icebergs;
- icing;
- waves;
- offshore structures;
- geotechnics;
- hydrocarbon exploration;
- North Sea offshore technology; and
- centrifuge modelling.

The collection covers the Beaufort Sea, East Coast Offshore and the Arctic Islands. Special emphasis has been given to identifying and indexing materials not readily available from other sources.

The collection currently contains:

- technical report literature from university, industry and government sources;
- papers from conferences, meetings and workshops;
- directories, bibliographies and atlases;
- annual reports;
- topographic maps and nautical charts; and
- meteorological, oceanographic and sea ice data in chart and tabulated format.

2.6.6 Canadian Centre for Marine Communication (CCMC)

Established in St. John's, Newfoundland, in 1989, the Canadian Centre for Marine Communications (CCMC) is mandated to assist Canadian industry in the development of products and services using advanced marine communications, navigation and information technology. Canadian companies and organizations direct CCMC and support it through membership. It is principally an initiative of the Atlantic Canada Opportunities Agency, Industry Canada, and the Fisheries and Marine Institute for the Memorial University of Newfoundland.

Its research includes:

- **SmartShip™ Program** assists Canadian industry in responding to commercial opportunities in the integration of ship communications and navigation products and services;

- **SeaComm Program** facilitates the international competitiveness of Canadian marine radio and satellite communication technology and applications. The focus is

on industry applications that will assist in the extension of the information highway to an affordable information seaway;

- **Infomarine Program** supports Canadian industry seeking the commercial opportunities for delivery of marine information technologies;

- **Information Seaway Initiative** addresses the expanding market associated with the provision of information technology, mobile communications technology, and navigation technology to support the expansion of the information highway into the marine environment; and

- **Marine Geomatics Initiative** - $2.5 million investment from ODF to capitalize on the global market for ocean mapping products and services.

2.7 RELATED BUSINESS SUPPORT

Only a few illustration of the range of business support available to cluster can be given here. They include:

- information systems such as those provided by NewTel Information Systems, which promotes its services as being the 8th largest information technology company in Canada;

- technical organizations, most notably the Newfoundland and Labrador Ocean Industries Association (NOIA);

- industry associations, such as the Defence and Aerospace Contractors of Newfoundland (DACON);

- finance and venture capital; among others, the Royal Bank is active in financing ocean-industry-related firms from its St. John's branch; and

- strategic planning and management aid, such as provided by Horizon Consulting.

2.8 RELATED PUBLIC SUPPORT

- training relevant to oceans and marine communications at the College for the North Atlantic;

- federal government support from ACOA, providing strategic intelligence, research and sometimes direct financial support;

- provincial government support, such as that provided by the Newfoundland and Labrador Ministry of Industry, Trade and Technology;

- municipal government support such as that provided by the St. John's Economic Development Department;

- technical data, such as that available from NRC's CISTI database; and

- skilled professional human resources, such as those available from Memorial University's oceans-related programs.

3.0 CLUSTER DYNAMICS

3.1 MARKETS

The local market is too small to sustain the development of technology-intensive firms. The major marine markets are in other parts of Canada and abroad. Some 80% of marine markets are outside Canada. It is very costly to gain access to these markets. To overcome distance problems, NewEast, for example, has put its marketing functions in major market areas (e.g. including Ottawa) while keeping other corporate functions (e.g. R&D) in St. John's.

Major issues related to distance to markets include:

- difficulty of getting international market intelligence;
- companies are not strongly linked to central Canada networks (e.g. invitations to trade missions).

3.2 LOCAL/REGIONAL LINKAGES

Industrial associations provide a first level of contact among firms and technical organizations. These include, for example, the Newfoundland and Labrador Ocean Industries Association (NOIA) and the Defence and Aerospace Contractors of Newfoundland (DACON).

However, project specific cooperation and alliances provide stronger linkages among key players. Examples of cooperation include:

- Sigma Engineering has developed the TITAN radar system which overlays the Infonav product and they run together with products from Consolidated Technologies;
- the Chartnet alliance sees NDI and Compusult of St. John's allied with Oracle and CARIS. NDI provides digital charts, Compusult provides its CIDAS data warehousing product;
- joint R&D projects between C-CORE and Northern Radar. C-CORE is central to the development of linkages among players in the ocean technology area;
- CCMC partners with and provides financing for marine IT and ocean mapping ventures.

Smaller firms with complementary capabilities can benefit by associating themselves with other firms and research organizations. However, this means that resources have to be devoted to these relationships. Very small firms, as is the case in Newfoundland, have limited resources,

so trade-offs between cooperation and 'going-it-alone" are always being made. There is also suspicion that other firms may steal ideas if relationships are too close. This perspective may inhibit the development of local linkages.

Firms can be too small to have the credibility needed to take on major contract (e.g. Northern Radar and government procurement).

3.3 EXTERNAL LINKAGES

Suppliers are mainly from outside Newfoundland. For example, Northern Radar obtains only some 20-25% of its supplies from Newfoundland.

Most local activity is in the assembly of components coming from elsewhere with some added value (e.g. hardware, software, design).

3.4 INFRASTRUCTURE

3.4.1 Technical Support

The availability of skilled people is essential to support cluster development. Memorial University (MUN) is a major source of technical people. There is also the College of the North Atlantic (formerly Cabot).

Since MUN will remain the principal source of qualified people, the university has to ensure that the skills of graduates continue to be in keeping with the needs of technology-intensive firms. This means that there has to be very close ties between MUN researchers and teaching staff with the firms in place

3.4.2 Business Support

Traditional banking and government financial instruments cannot deal effectively with start-up situations. New mechanisms such as CCMC are emerging. However, informal and formal venture capital is not well developed.

3.5 SUMMING UP

The cluster dynamics reflect the behaviour of small individualist firms in an emerging technological domain.

Some firms with complementary capabilities have been working together, along with research organizations. More projects that bring firms together are needed to develop critical mass and credibility as well as to overcome the resistance of working in alliances to reach international markets.

All of the ingredients required for a strong ocean technological cluster are in place:

1. strong local market (fisheries, oil, and gas);
2. very good, well connected SME's; and
3. good institutional support (IMD, C-CORE,etc).

4.0 ISSUES IN CLUSTER DEVELOPMENT

4.1 OVERALL CLUSTER STRATEGY

The overall cluster strategy has been to capitalize on innovative products and services for niche markets. Benefits of this strategy are the wide range of products and services provided by the cluster. Moreover, they incorporate significant leading-edge technical capabilities and, have linkages to R&D results available within the cluster.

However, less positive features are the typically small number and size of the commercial firms. Moreover, the small firms sometimes have difficulty seizing market opportunities, given their "niche" specialties. Continuity of markets has also been a limiting factor for some of the firms in the past.

4.2 ISSUES IN CLUSTER DEVELOPMENT

A major issue facing the cluster seems to be the lack of a focal point in the sense of a larger commercial organization (or possibly some form of private-public partnership) that could act as a "systems integrator" to the disparate, but technically qualified, smaller firms. On the other hand, there has already been an important degree of integration within the cluster, for example, the new, emerging Stratos conglomerate for wireless communications and marine communications through satellite links. It is possible a parallel organization for the oceans technology elements could also be developed.

Other issues related to the future development of this cluster include:

- ensuring continuity of markets and internal development of the cluster ;
- developing broad-based oceans technology and marine communications capabilities that would be applicable not just in North Atlantic or even cold water environments but globally; and
- explicitly capitalizing on new opportunities both in Canada and overseas;
- obtaining international market intelligence;
- developing international marketing skills;
- developing projects (e.g. product development, R&D, marketing) that bring together firms and research organizations with complementary capabilities. Working together can provide critical mass and overcome suspicion. The electronic chart could possibly be a project area.
- emphasis and recognition of oceans as an important economic sector by the federal government (even 1/10 th of what is spent on the space sector would help).

4.3 POTENTIAL PROJECTS

Taking concurrence that a "systems integrator" is required for this cluster, then options could include external investment attraction or development of a larger integrator within the cluster based on a "solutions" outsource approach by major procurement agencies. More project options could exist in conjunction with other clusters.

Some near-term projects could be:

- environmental projects;
- oil and gas-related projects;
- aquaculture projects;
- co-operative geomatics projects;
- seabed and other mining/exploration projects; and
- integrated traffic management projects.

V THE NOVA SCOTIA MEDICAL DEVICES AND SERVICES CLUSTER

1.0
HIGHLIGHTS

Nova Scotia's medical services capability is leading-edge, up to the most sophisticated organ transplant and cancer therapy. Moreover it has explicit differentiation between major demographic segments of the population, i.e., obstetrics, child care, adult care, geriatrics and even psychiatric therapy. Backing this service delivery capability are specialized medical services programs such as organ transplant, maternity, intensive care, childhood diseases and innovative patient care programs such as "Care-by-parent".

Other specialized capabilities and devices underpinning the medical services cluster in Nova Scotia also include:

- fatty acid research;
- blood test kit production;
- emergency vehicles and related parts;
- biotechnology capability;
- testing and diagnostics;
- medial packaging and containers;
- medical clothing;
- plastics for medical applications;
- telemedicine systems; and
- medical health care management systems.

A significant research capability exists in the cluster, including research based on:

- cardiac prevention;
- children's illnesses;
- relevant university research;
- pharmaceuticals;
- teaching hospitals;
- home care techniques;
- clinical trials;
- dedicated science parks; and
- technical schools.

There is a network of related business support backing the cluster's services, products and research.

The range of services provided in the cluster has a value far exceeding that of the supporting medical capabilities and products. Much of the current services are supported by imported machinery and equipment, and implicitly-imported research. However, the major beneficiaries of the cluster are regional.

There is some export of services in the sense that Nova Scotia is becoming a medical hub for all of Atlantic Canada (also including St. Pierre and Miquelon). There are much bigger growth opportunities in finding ways to export the cluster's services further afield. As well, there would appear to be growth opportunities in developing medical products and services in Nova Scotia in parallel to the success the cluster has had in attracting (for example) blood-testing capabilities. The fact that Nova Scotia has a competitive cost advantage in manufacturing over other parts of North America – highlighted by recent studies showing comparable manufacturing costs are lower in Nova Scotia than other locations – suggest an increased production/manufacturing role may well be possible.

The medical market is highly fragmented. It is served by firms that have unique products and as such do not need to cooperate with each other.

Most supplies and components, even low technology ones, come from outside the region. The quality of local products is an issue.

However, the universities provide the needed medical staff. The availability of professionals as well as training and R&D capabilities can attract firms. Moreover, explicit efforts at improving linkages within the cluster are underway, such as the operation of the Clinical Trials Atlantic Consortium, and ACF Equity Atlantic and Canadian Medical Funds, are helping address investment needs.

Issues in developing this cluster include:

- the lack of linkages and interaction within the cluster;
- the lack of firms with ISO 9000 certification;
- the lack of private investment instruments;
- a regulatory process that is perceived to lag behind that of other countries.

Some specific potential projects for this cluster could include further research on, and development of, "outsource solutions" for hospitals and new health care management technologies.

Exhibit V-1 gives an overview of the Nova Scotia medical devices and services cluster.

Exhibit V-2 provides a summary of the current development status of the medical devices/services against the eight ingredients of success. This cluster has all the problems related to a nascent cluster. While the potential is recognized and there is a strong educational and R&D base, attention has to focus on the business and networking aspects of the cluster.

Exhibit V-1 - Nova Scotia Medical Devices and Services Cluster

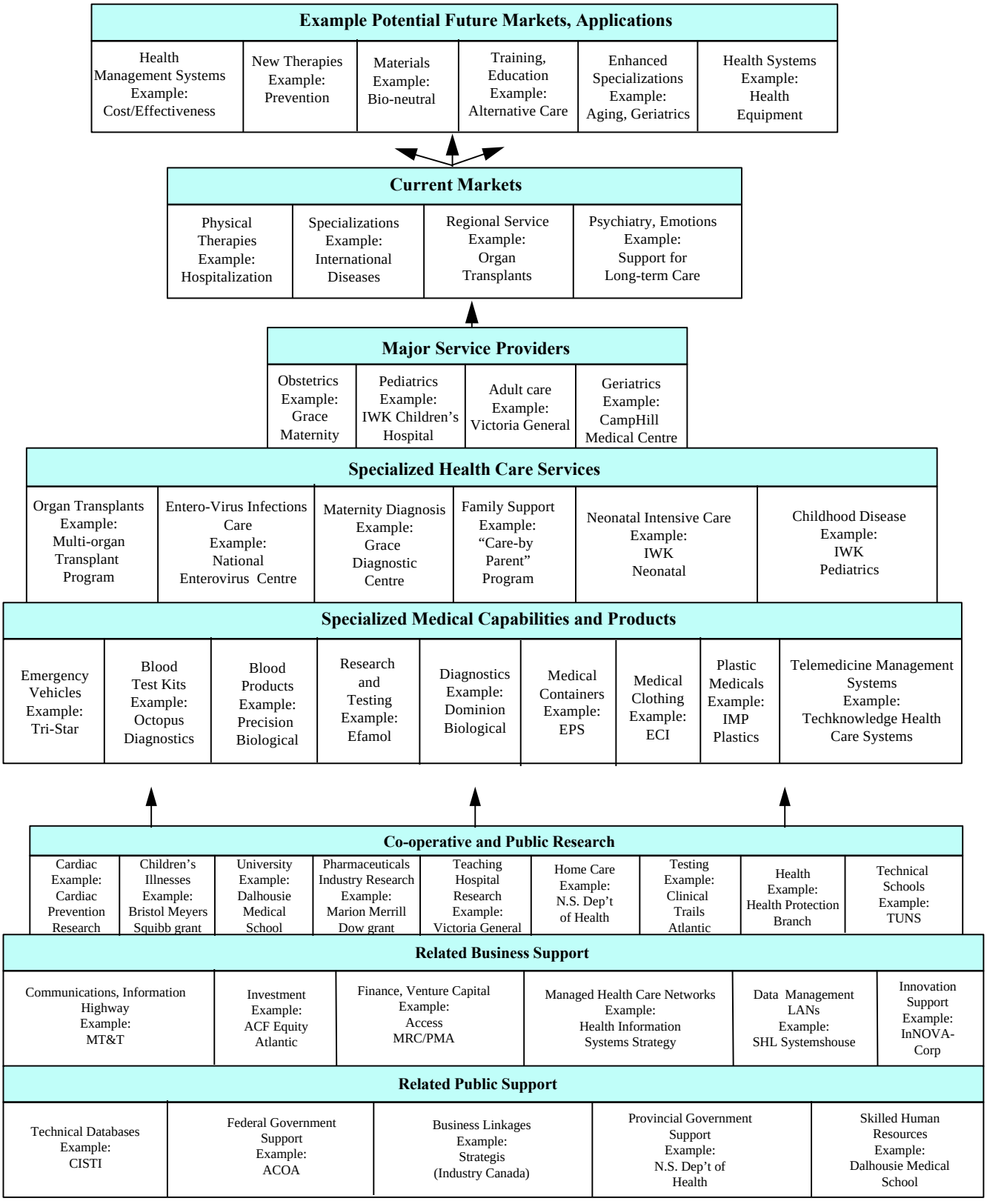
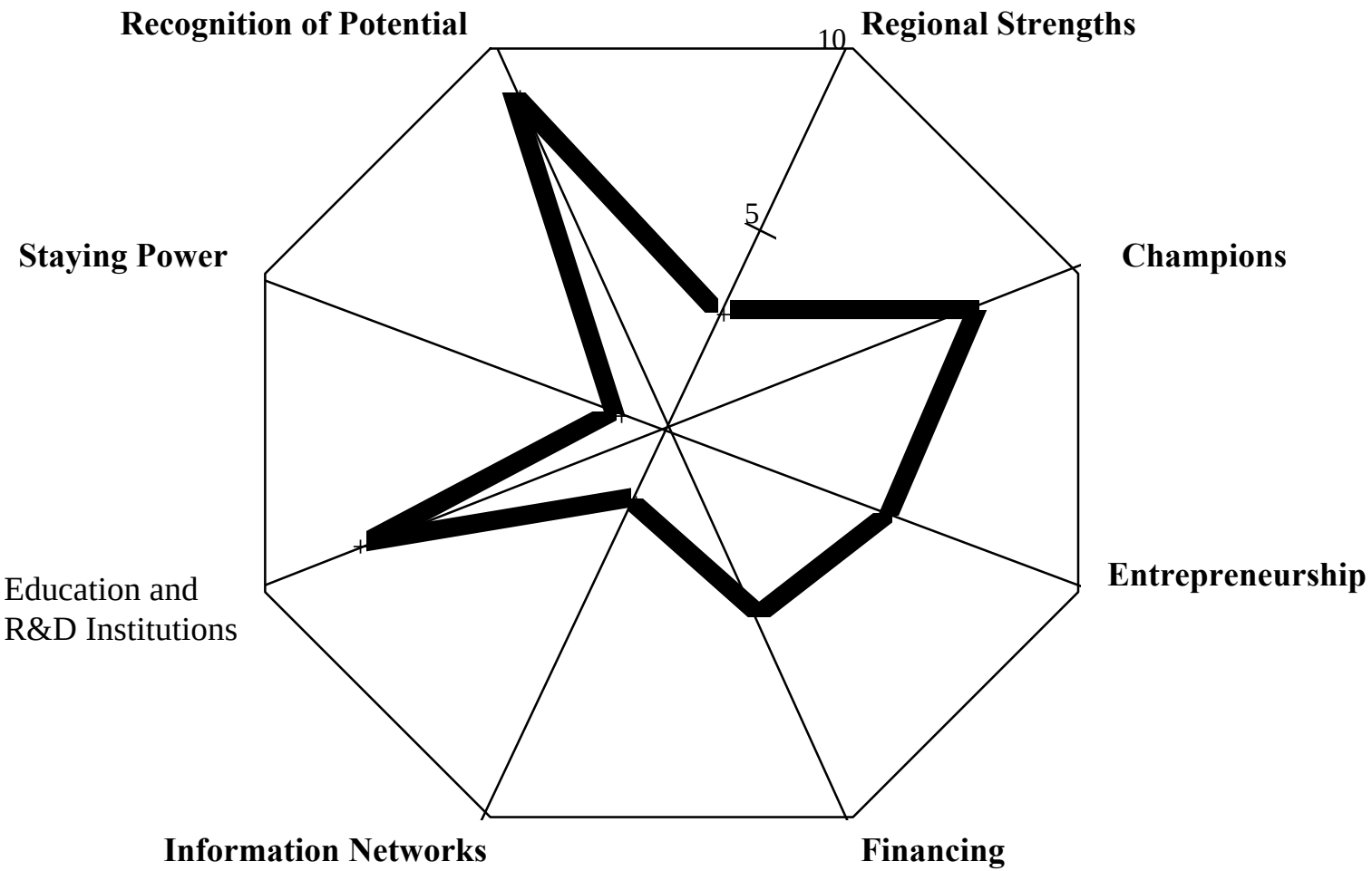


Exhibit V-2: Development Status of the Nova Scotia Medical Devices & Services Cluster



2.0
CLUSTER PROFILE

2.1 CURRENT MARKETS

Current markets for the Nova Scotia medical devices and services include:

Physical Therapies

The range of hospitals available in Nova Scotia are sufficient to provide a full spectrum of physical therapies, moreover, demographically differentiated through such care as obstetrics, maternity, child care, adult care, geriatrics and acute care. Virtually all physical therapies are available, up to the most complex organ transplant operations.

Specializations

A number of specializations have already appeared in the Nova Scotia medical cluster, including specialized research and treatments for international diseases and blood diagnostics/analysis/treatments.

Regional Service

Within the Atlantic Canada region (including St. Pierre and Miquelon Islands, part of metropolitan France) the Nova Scotia medical cluster has become pre-eminent in terms of physical therapies and diagnostics.

Psychiatry, Emotions

As part of the on-going long-term care and acute care facilities within the cluster, Nova Scotia has also developed a relevant psychiatric and emotional care capability, particularly in respect of ageing and long-term disabilities.

2.2 EXAMPLE POTENTIAL FUTURE MARKETS, APPLICATIONS

Future markets and applications that are beginning to appear, in published literature and by analysis, include:

Health Management Systems

In all of North America, health care expenditures are becoming a rising share of all costs. This phenomenon is putting a premium on health management systems that offer increased efficiencies and effectiveness both from a standpoint of costs as well as from the standpoint of patient well-being. Nova Scotia has an opportunity to capitalize on both its current capabilities and also its current customers to develop better systems.

New Therapies

An ageing population in Canada and across North America means many new opportunities exist for experimental therapies. Nova Scotia is well-placed to capitalize on such opportunities by virtue of its existing capability, stable population, and low costs.

Materials

Modern medical science needs new materials for therapy, packaging, transport and ease of use. Given the existing base, this option could be exploited by the cluster.

Training, Education

Health care training and education is likely to be a high-growth area for the future in North America. the strong university and college programs in NS could be used for commercial exploitation, especially at the post-grad level and in management specialization.

Enhanced Specialization

There will likely be further potential for enhanced specializations by the NS medical cluster; an excellent example is geriatric care, derived from the stable, ageing population but meant to be an exportable service capability.

Health Systems

Modern health care concepts are based on information. The data is derived from lab research and experimentation, individual statistics and sensor readings, and social group dynamics (largely expressed statistically). The storage, processing and interpretation of this data requires extensive systems capability based on computers, telecommunications, imaging, display devices and therapeutic monitoring. This is a growth market.

2.3 VALUE OF CLUSTER OUTPUT

No exact figures on the output of this cluster appear to be available. A detailed strategic assessment of the cluster has been done recently by the government of Nova Scotia. This assessment also established goals for the cluster over the next five years. The goals include attracting tens of millions of dollars in new capital investment in the five year period, producing corresponding increased value of annual exports outside the region, and providing several hundred on-going high-value jobs. This strategy also breaks down the overall goals into various sub-cluster goals such as health systems, blood technologies, health management, health research and commercialization, medical devices, health information and others.

2.4 MAJOR SERVICE PROVIDERS

The Nova Scotia medical devices and services cluster is built around several major service providers who offer both general and specific health care to the region. Some illustrations taken from the Greater Halifax area give a flavour for the service capabilities in the cluster. A feature is the demographic division available just in the Halifax area alone – with separate facilities for adults, children, obstetrics and maternity, and generations and long-term or acute-care.

2.4.1 Victoria General Hospital

- teaching and research hospital;
- major adult care hospital with over 750 beds;
- one of the most significant hospitals in Canada;
- more than 270 active medical staff;
- many specialized programs; and
- 4000 employees.

The Victoria General Hospital is Nova Scotia's major adult care facility. Many of the cluster's specialized programs are operated within this hospital (see below). It offers a full spectrum of comprehensive adult health care. Many patients are brought in from all over Atlantic Canada.

2.4.2 Izaak Walton Killam (IWK) Children s Hospital

- Atlantic Canada's center for pediatric care;
- pediatric teaching hospital;
- childhood disease control;
- over 200 beds;
- neonatal care; and

- specialized children's care.

This hospital offers full-spectrum children's care. All aspects of pediatric care are available through this facility, and the hospital has gained an international reputation for excellence in health care for children, up to 16 years of age. Several specialized programs involving research, test and treatment for childhood diseases are underway. Each year, about 200 children from other Maritime provinces are brought in for specialized care at the IWK. Over 7,000 child patients are admitted each year in total. The hospital is affiliated with Dalhousie University.

2.4.4 Grace Maternity Hospital

- obstetrics; and
- maternity.

The Grace Hospital specializes in obstetrics and maternity, accommodating 6,000 births every year. It has full-spectrum capability for these services. It also carries obstetric-related specialized programs.

2.4.5 CampHill Medical Centre

- geriatrics;
- adult-care; and
- psychiatry.

The CampHill Medical Center is a union of three facilities, the Halifax Infirmary, CampHill Hospital, Abbie J. Lane Building, and Veterans' Memorial building. It is the region's major long-term and acute-care facility. Besides physical care, the Center offers psychiatric and mental/emotional health services.

2.4.6 Others

There are eight hospitals just in the Greater Halifax area. Numerous other patient-care facilities exit across Nova Scotia.

2.5 SPECIALIZED HEALTH CARE SERVICES

Backing the broad-spectrum service providers are significant specialized health care services. They include:

2.5.1 Multi-organ Transplant Program

All major organ transplants in Atlantic Canada are done through this program, run by the Victoria General Hospital. The operations conducted each year include liver, kidney and heart transplants. At the present time these remain the most complex and challenging of surgical therapies, and is strong evidence of the leading-edge services of the cluster.

2.5.2 National Entero-virus Centre

The Victoria General Hospital was selected in 1994 to become the site for the National Entero-virus Center. The center provides expertise in the identification, diagnosis and research of entero-virus infections, whose effects range from polio to the common cold. The Center is also part of the national links to the federal laboratory Center for Disease Control.

2.5.3 Clinical Investigation Unit

Run from the Grace Maternity Hospital, the Clinical Investigation Unit supports the Grace Hospital's renowned obstetric diagnostics capability. The Unit is unique in Canada and has an explicit goal of facilitating technology transfer from researchers/investigators to maternity clinicians.

2.5.4 Innovative Support Programs

The IWK Children's Hospital gives personalized care to its children patients, and the Hospital's policy is to involve the whole family in care for its patients. This has led to its innovative "Care-by-parent" unit, in which parents and family members have the opportunity to assist in the care of the child. This program is designed to ease the natural fear of children at being in a strange and potentially frightening environment.

2.5.5 Childhood Disease Program

The IWK also has major programs in prevention, diagnosis and treatment of childhood diseases. These include common ailments like measles up to much more serious problems.

2.6 SPECIALIZED MEDICAL CAPABILITIES AND PRODUCTS

Backing the first and second tiers of service providers, there is a very wide range of firms providing specialized medical capabilities and products in the cluster.

Only a limited selection is presented here, but these firms serve to show the range of capabilities. They include:

2.6.1 Tri-Star Ltd.

This firm, based in Yarmouth, N.S., produces custom emergency vehicles (ambulances) and related parts such as lights and specialized handling equipment. The firm has revenues over $8 million annually.

2.6.2 Efamol

Efamol is well known for its research on pharmaceuticals. The company also provides in house testing capability. It has worked in blood-related medical biologies. The firm has about 80 employees.

Efamol made big news all across the country recently in an AIDS breakthrough. Efamol Research/Scotia Pharmaceuticals of Kentville, Nova Scotia, had developed a drug that, in laboratory testing, not only killed off infected cells but protected normal cells from the human immuno-deficiency virus. In clinical trials in Britain, the drug was shown to prolong the survival rate of patients with pancreatic cancer by four times.

2.6.3 Dominion Biological Inc.

Dominion Biological is a well-established blood-related biologic firm. It makes blood grouping and typing re-agents. It is also active in the production of diagnostic immuno test systems, and anti-tumor serums. There are over 30 employees.

2.6.4 Precision Biologicals

Also relating to blood biologics is Precision Biological. The company makes lab clinical diagnostics, lab fecal transport systems, parasitology supplies, and frozen plasma controls. There are 12 employees.

2.6.5 Octopus Diagnostics

This firm is well known for its blood test kits, another of the specialized blood-related biological firms in the cluster. The firm is also moving to capitalize on health research and commercialization.

2.6.6 Environmental Packaging Systems (EPS)

This small but growing company specializes in providing containers that are related to dangerous infectious diseases, for shipping specimens, serums, bioassays, etc.

2.6.7 ECI Medical Technologies

This firm produces medical clothing and is well-known for its surgical gloves. It is based in Bridgewater, N.S. There are about 50 employees.

2.6.8 IMP Plastics

IMP Plastics is part of the IMP Group International, a large conglomerate with at least ten divisions operating in Nova Scotia. IMP Plastics provides specialized medical products such as neo-natal intravenous needles and selected plastic injection molding products. There are 4 employees.

2.6.9 Techknowledge Health Care System

This firm has developed "managed health care" system and software. One of the firm's major applications is in telemedicine diagnostics. This Dartmouth-based software firm has signed a partnership agreement with a U.S. firm, Medical Image Management, to bring a telemedicine system to Canada. It will allow diagnostics via videoconferencing, digitized X-ray images, and ultrasounds at a distance.

2.7 CO-OPERATIVE AND PUBLIC RESEARCH

Supporting the service providers and the specialized capabilities and products is a well developed research base. It includes:

- organ-specific research such as cardiac research at Cardiac Prevention Research;
- childhood diseases research underwritten by a grant from a U.S. medical company, Bristol-Meyers-Squibb;
- university research, such as at Dalhousie Medical School. It includes the Division of Biomaterials Science, Dentistry which researches the development and evaluation of materials to replace natural tissues in dental, medical and surgical procedures. The Population Health Research Unit (PHRU) conducts research studies in Nova Scotia, including epidemiological studies and health services investigations. Industrial Research Chairs present opportunities for the university to respond to industrial needs. Dalhousie has established chairs in dental biomaterials, and environmental observational technology. Vision 2000 Laboratories in the Faculty of Medicine provide R&D collaboration with industry in areas such as molecular neurobiology and immunomodulation;
- pharmaceutical research, such as that provided by funding from a U.S. pharmaceutical company, Marion-Merrill Dow;
- research as part of a teaching hospital curriculum, such as at Victoria General;
- specialized Home Care research underway at the Nova Scotia Department of Health;
- a major testing initiative, Clinical Trials Atlantic. This initiative is driven by the "Clinical Trials Coalition", an outgrowth of the Atlantic Canada Pharmaceutical Showcase. It received start-up support from ACOA ($250,000) and the Pharmaceutical Manufacturers' Association of Canada ($500,000). Clinical trials involve testing drugs under development for safety, efficacy and efficiency in human populations. The work translates into financial benefits for hospitals and medical practitioners. It also serves to enhance skills and awareness in health care management and research, and epidemiology. A major advantage of the Atlantic region is its relatively stable population. This reduces the "drop-out" rate and hence the cost of trials. It also makes examination of effects related to heredity more amenable to study. Coalition members in Nova Scotia include the medical faculties at Dalhousie and Memorial universities together with the Camphill Medical Centre (Halifax), the Victoria General Hospital (Halifax), and the Isaac Walton Killam Hospital (Halifax);

- managed health care, the application of information technology to improve patient treatment and reduce costs. Nova Scotia has been active in this application through its extensive software engineering capability, encompassing dozens of firms;

- technical training and research such as at TUNS; and

- health protection research through the federal government's Health Protection Branch facilities. The new Health Canada – Health Protection Branch (Atlantic Region) facility was opened in Dartmouth, N.S., in 1992. The building houses the Audit, Drug, Environmental Health Inspection, and Product Safety divisions, as well as the Laboratory division and AAFC Food Inspection program. Some important units of the Branch in Nova Scotia include:

    - The Microbiology Lab assesses a wide variety of foods, with emphasis on microbiological safety, consumer complaints and illness response.

    - The Food Chemistry Laboratory is designated a centre of expertise for the analysis of trace elements in foods and is also designated a national centre of expertise in support of the nutritional labelling and economic fraud program.

    - The Atlantic Drug Analysis Laboratory (DAS) is one of five national program laboratories which supports law enforcement agencies in their fight against illegal drugs.

    - The Product Safety program of the Environmental Health Directorate has the mandate to reduce injuries and deaths related to hazardous products. This, in part, is accomplished through the administration of the Hazardous Products Act. The program contains sections which pertain to chemical, mechanical, flammable and biological hazards, as well as an information component.

    - The Drug and Environmental Health Unit inspects manufacturers of pharmaceutical and medical devices and investigates complaints. The auditors are responsible for ensuring the food health and safety standards are met by other federal departments.

2.8 RELATED BUSINESS SUPPORT

The infrastructure and business support provided in Nova Scotia is extensive. It includes:

- information highway links provided by MT&T, Cable operators, and Internet service-providers;

- management of health care networks, such as the Health Information Systems Strategy;
- innovation support from In*NOVA*corp. The Nova Scotia Innovation Corporation (In*NOVA*corp) is a technology commercialization corporation whose aim is to assist Nova Scotia companies to compete in export markets via improved technology, products and services. As a provincial crown corporation, In*NOVA*corp offers scientific, engineering and business extension services to assist in developing and commercializing in new technology-based products and services. Linked to universities, research institutions and companies throughout the province, In*NOVAcorp* assists Nova Scotia companies in developing trade links for their products; and
- finance and venture capital such as that available from ACF Equity Atlantic.

2.9 RELATED PUBLIC SUPPORT

- CISTI, Canada's largest technical database from the NRC, accessible at several locations in Nova Scotia;
- federal government support from ACOA;
- provincial government support form the Nova Scotia Department of Health;
- skilled human resources such as those available from Dalhousie University Medical School; and
- business linkages available from the "Strategis" database of Industry Canada.

3.0
CLUSTER DYNAMICS

3.1 MARKETS

The medical cluster is a young and very thin cluster with no compelling marketing reason for many of the firms to be located in Nova Scotia since their principal markets and inputs are external to region.

Service markets are emerging locally based on the breath and depth of local medical R&D expertise (e.g. clinical trials). Telemedicine is developing rapidly.

3.2 LOCAL/REGIONAL LINKAGES

There is little need for interaction among players in the cluster because the firms tend to produce niche specific products for international markets. There is little competition in the region.

High costs and the difficulty of maintaining consistent quality standards inhibit links between clients and local suppliers. There are not enough local suppliers to warrant purchasers to adopt to their standards, especially given relationships with suppliers from outside the region.

In the pharmaceutical area there are linkages between firms and the Dalhousie medical school.

NovaCorp. and The Greater Halifax Partnership are pushing to increase linkages both locally and internationally.

3.3 EXTERNAL LINKAGES

The vast majority of medical equipment and products are imported into the region. Some low technology products are produced locally.

To sell internationally requires operating under ISO 9000 standards. Few local manufacturers have this quality certification. This forces companies, such as TriStar, which sell internationally to get their components from ISO 9000 certified firms outside the region.
In the pharmaceutical area there is much international collaboration, especially with countries where regulatory approvals are easier. Canada is considered to have a slower, more expensive regulatory approval process.

3.4 INFRASTRUCTURE

3.4.1 Technical Support

The regional universities and colleges provide the necessary skilled people. The skills base in the medical area is used as a marketing ploy to attract pharmaceutical R&D and clinical trials to the cluster.

Advanced communications systems are important for the development of the cluster because companies do not have sufficient contacts with like or complementary firms locally so they need to communicate with firms outside the cluster. They need to communicate to firms in international markets and to parents outside the region.

3.4.2 Business Support

Government programs and incentives (federal and provincial) are supporting this cluster. The federal R&D tax credits are particularly helpful to pharmaceutical firms.

3.5 SUMMING UP

The medical market is highly fragmented. It is served by firms that have unique products and as such do not need to cooperate with each other.

Most supplies and components, even low technology ones, come from outside the region. The quality of local products is an issue.

The universities provide the needed medical staff. The availability of professionals as well as training and R&D capabilities can attract firms.

4.0
ISSUES IN CLUSTER DEVELOPMENT

4.1 OVERALL CLUSTER STRATEGY

Nova Scotia's medical services cluster development is driven by government. The aim is to attract medical devices/services related investment to the province.

The range of services available from this Nova Scotia cluster is extensive. There are leading-edge capabilities such as organ transplants, and includes the National Entero-virus Center.

The implications of this service capability are that medical skills and knowledge, in the broadest sense, are leading-edge within the cluster. The challenge lies in turning these medical skills into exportable devices and services.

4.2 ISSUES

Some issues to address include:

- the lack of linkages and interaction within the cluster;
- the lack of firms with ISO 9000 certification;
- the lack of private investment instruments;
- a regulatory process that is perceived to lag behind that of other countries.

4.3 POTENTIAL PROJECTS

Some specific potential projects for this cluster could include further research on, and development of, "outsource solutions" for hospitals and new health care management technologies.

VI THE PRINCE EDWARD ISLAND AND NEW BRUNSWICK FOOD PROCESSING CLUSTER

1.0
HIGHLIGHTS

The Prince Edward Island and New Brunswick food processing cluster offers a complete supply chain from agricultural inputs such as produce and bulk milk all the way up to world-renowned multi-line brand name packaged products widely available in supermarkets across Canada and North America. The complete nature of the supply chain through increasingly value-added products is striking and highly significant.

Some of the multi-line brand names originating in the PEI/NB food processing cluster include McCain Foods, Baxter Foods, Cavendish Farms and Brunswick.

A significant second tier of bulk (intermediate) producers and specialty food producers back up the multi-line brand name firms, including:

- tasty snacks and potato chips;
- milk products;
- dairy products;
- beer and ale;
- fine foods; and
- seafood specialties.

There is an in-depth tier of inputs to this food processing cluster, including:

- dairy farming;
- vegetables;
- potatoes;
- fisheries;
- seafood catches;
- waste disposal equipment and systems;
- food-related process controls; and
- fish and veterinary health services.

A very diverse tier of co-operative and public R&D backs up the food processing chain in the cluster. It includes:

- food research;
- food production technical support;
- energy research;
- technology development related to food;
- agricultural research;

- conservation;
- fire safety research;
- water and groundwater experimentation; and
- spray technology.

There is a wide range of related business support units.

Costs are a factor. In the past transportation costs have worked against food processors in the region. It was cheaper for agricultural products to be exported directly, processing being carried out nearer larger markets in central Canada. This is still true to a considerable extent today. However, this may show a changing trend in the future. In particular, improved transportation links in the region, particularly in respect of rail networks connecting to the proposed expanded Port of Halifax, and providing a high-volume direct link to large markets in central Canada and even mid-west US, may help to re-dress the cost balances in favour of regional processing. As well, there may be opportunities to set up increased numbers of "premium" packaged food lines that can justify relatively long-distance transport, thanks to increased R&D and innovation within the cluster. Lastly, there may also be positive opportunities to alleviate cost problems by attracting more "head office" functions in food processing firms, to the region.

Potential growth opportunities and challenges to the cluster are to: first, diversify the agricultural inputs, machinery and equipment and specialized services that originate inside the cluster itself; and, second, to squeeze still higher levels of value-added from the existing supply chain, (for example, adding still more detailed arrays of niche products).

This sector is driven by a few large vertically-integrated firms. These firms are self-contained and do not interact closely with other firms and institutions in the clusters.
Smaller firms, while they do not cooperate closely with each other, do interact closely with the publicly funded infrastructure, especially for R&D and technical support. Export markets are dominated by larger firms, regional markets are not.

Issues in developing this cluster include:

- value-added from the agricultural product base: this will have to take into account the relative economics of different farm commodities, possible candidates might include hog- and chicken-based food chains, capitalizing on existing farm surpluses and even waste commodities;

- linkages to the emerging aquaculture capabilities in Atlantic Canada;

- developing a specialized machinery and equipment capability in support of high-output food processing, particularly flexible manufacturing systems applied to the PEI/New Brunswick product lines;

- developing a regional capability to systematically acquire, store and disseminate novel food processing techniques and ingredient combinations (literally food recipes) so as to enhance the cluster's ability to respond to global markets;

- bridging the training gap and the availability of skilled people;

- providing financing to smaller firms;

- providing business training including marketing; and

- irrigation systems to ensure consistent quality of crop.

Exhibit VI-1 gives an overview of the Prince Edward Island and New Brunswick food processing cluster.

Exhibit VI-2 summarizes the current development status of the food processing cluster. This is a mature cluster which needs to address key entrepreneurship, financing and networking issues in order to renew itself to seize new opportunities.

Some specific potential project develoments for the cluster could include:

- developing promotional material for vegetables;
- promoting "wildbush" blueberry exports, apples, and other fruits;
- support for market research and export clubs, e.g. in Europe (Germany);
- more efficient uses of pesticides and machinery;
- use of computers in the cluster/industry for information transfer;
- developing an internship program; e.g., staff from a research center spend 4 to 6 months inside a project developing firms; also co-op program or apprenticeships;
- Agri-food Council could be a "champion", and potential integrator on marketing side;
- promotion of ISO 9000 approach for safety standards;
- "meal solutions" packaged meals; and
- investigation of cost structure e.g. HST, safety standards, etc.

Exhibit VI - Prince Edward Island and New Brunswick Food Processing Cluster

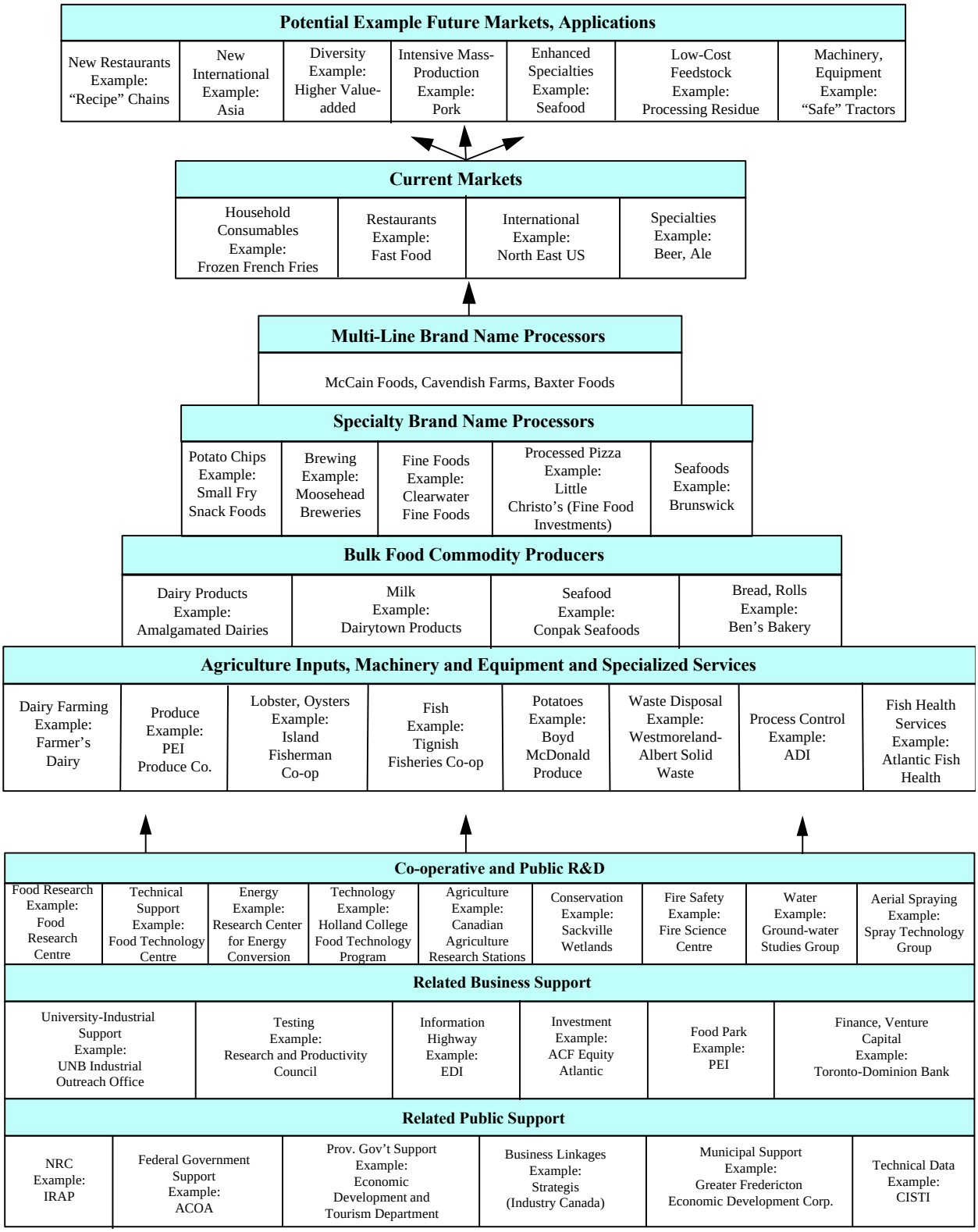
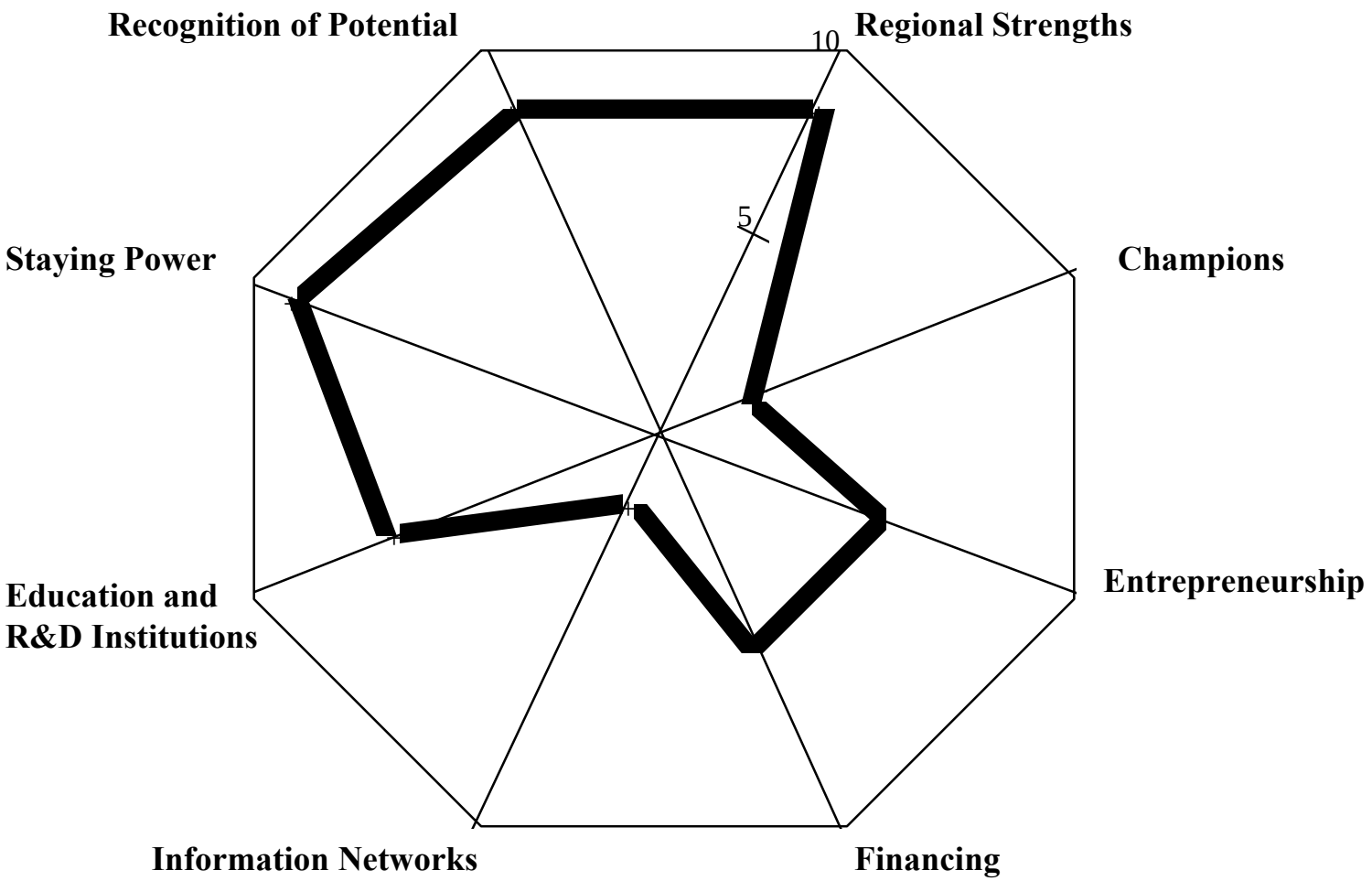


Exhibit VI-2: Development Status of the NB/PEI Food Processing Cluster



2.0
CLUSTER STRENGTHS

2.1 CURRENT MARKETS

To give a realistic view of the scope of current markets for the Prince Edward Island and New Brunswick food processing cluster, the following opportunities, currently being exploited, are good indicators:

Household Consumables

Everyday householders across Canada, the U.S. and in many places around the world purchase PEI/NB processed foods for tasty nourishment. Potatoes and milk may be common human foodstuffs, but they are still noble commodities in light of the fact that we all have to eat.

Restaurants

This has been and continues to be a growth market; in North America, between one in two and one in three meals are eaten outside the home. A famous restaurant chain suggests it has served billions of hamburgers. Its "french fried" potato servings are at least 20 times higher.

International

Canadian foods have occasionally achieved international renown. Large, nearby, consumer markets such as the north-eastern U.S. have represented a valuable market for the cluster.

Specialties

The region has developed specialty, brand-name processed foods, not always in the obvious commodities. A good example is Moosehead Ale.

2.2 EXAMPLE POTENTIAL FUTURE MARKETS, APPLICATIONS

Potential future markets and applications could include:

New Restaurants

The trend toward eating outside the home continues. There could be promising new restaurant chains capitalizing on "lite" meals, vegetarian, seafood or something else the region could produce more effectively than other competitors.

New International

Industrialization brings about increased per capita disposable income and this makes openings for higher-value-added tasty foodstuffs in international markets.

Diversity

The cluster could move into diverse, but related foodstuff markets such as red meats, poultry or other commodities, linked to efficient use of resources including processing waste residues. Other possibilities include diversifying into medicines and pharmaceuticals.

Intensive Mass Production

Many modern agricultural producers resemble intensive manufacturing operations in terms of large scale, manipulated growth, and non-seasonal "harvesting". This opportunity may exist in PEI/NB based on existing technology and output (e.g. intensive hog or poultry production).

Enhanced Specialties

Further development of premium brand image and other specialties may exist, particularly in respect of specialized dietary considerations (e.g. fish as a low-fat "lite" foodstuff).

Low-Cost Feedstock

There may be an opportunity to go "down-market", i.e. to produce low-cost feedstocks for other producers (e.g. potato residue for hog feed).

Machinery, Equipment

The food processing cluster may be able to generate new ideas from its operation concerning specialized machinery and equipment. These could be exportable items in this own right.

2.3 VALUE OF OUTPUT

Total value of the commercial output of the cluster, taking into account just the processing operations within the region, is estimated at approximately $1.86 billion annually. One single firm, McCain's from Florenceville, NB, alone has annual revenues of $4.3 billion, but this is misleading, as only a portion of the firm's processing is done within PEI/NB, the rest being done in several different locations across North America. Moreover, the second largest food processing firm, Cavendish Farms, has total sales in the order of $250 million annually and Baxter Foods, third largest, is at about $160 million annually.

The government of New Brunswick in its 1993 Strategy for Economic Development uses Statistics Canada data to indicate Food and Beverage processing is 22.6% of all manufacturing output for the province. Applying this proportion to the 1995 value of NB manufacturing of $7.868 billion gives the cluster commercial value figure as $1.778 billion, to which PEI's total 1995 food value-added manufacturing of $110 million would have to be added for a grand total of $1.88 billion. Food processing is the second-largest manufacturing sector in New Brunswick (only forest industries are larger).

2.4 MULTI-LINE NAME BRAND PROCESSORS

The PEI/New Brunswick food processing cluster benefits from food products manufacturers who carry multi-line name brands. Such firms represent the peak of the " manufacturing food chain" in any cluster. They demonstrate total capability in the cluster from the standpoint of research, production, distribution, marketing and management skills.

2.4.1 McCain Foods

- packaged frozen foods;
- packaged drinks such as orange juice;
- specialty foods;
- research and development; and
- recognized brand names.

At over $4 billion annual sales in 1996, McCain Foods is the largest firm in Atlantic Canada revealing its total revenues. Growth has been 23% in 1996 over 1995 – a very impressive performance. The firm is famous for its brand name frozen french fries but offers many other products as well. Some of its products include cakes and pastry, broccoli, peas and pies.

2.4.2 Cavendish Farms

- frozen foods;
- packaged foods; and
- specialties.

A famous brand name in Canada, Cavendish Farms raises, harvests and processes numerous food products in Canada. Some of their products include french fries, peas, potato products and potato skins.

2.4.3 Baxter Foods Ltd.

- packaged foods;
- brand names; and
- specialty foods

At $167 million in annual sales, Baxter Foods is the second largest food processor (that provides sales revenue figures), within Atlantic Canada. Some of their products include cream, chip dip, margarine, shortening, vegetable oil, sherbets and bottled spring water.

2.5 SPECIALTY BRAND-NAME PROCESSORS

Backing the multi-line Brand Name processors is a spectrum of specialty product producers and intermediate bulk food commodities. These include:

- Brand-Name specialty potato chips, and snacks, such as those produced by SmallFry Snack Foods. The company has more than 50 employees;

- Brunswick multi-line brand name based on seafood. It includes oysters, sardines, scallops and kippers;

- beers and ales such as those produced by Moosehead Breweries using its own brand name;

- fine foods and premium products, for example, the lobster output of Clearwater Fine Foods; and

- diverse or unusual recipes, such as those used by Fine Food investments to make their award-winning Little Christo's pizzas.

2.6 BULK FOOD COMMODITY PRODUCERS

- dairy products, produced by many major dairies in the region such as Amalgamated Dairies. The company produces butter, cheese (numerous varieties), and ice cream;
- bulk processed milk, for example, Dairytown Products, another major diary operation;
- seafood, such as that from Conpak Seafoods; and
- baked goods, such as those of Ben's Bakery.

2.7 AGRICULTURE INPUTS, MACHINERY AND EQUIPMENT AND SPECIALIZED SERVICES

The agriculture, machinery and services spectrum available as inputs to PEI/New Brunswick food processors is significant and has depth, but is somewhat narrow. Naturally enough, it is concentrated on product lines used by the food processors in the region. It includes:

- large dairy farming operations such as Farmer's Dairy;
- potatoes such as those from Boyd McDonald Produce;
- produce and vegetables farming such as PEI Produce Co.;
- lobster and oyster cultivation such as Island Fisherman Co-operation;
- fish, from such fisheries as Tignish Fisheries Co-operative;
- seafood varieties, such as those produced by Conpak Seafoods;
- unusual services, such as waste disposal provided by Westmoreland-Albert Solid Waste;
- process control for food manufacturing operations such as those of ADI Inc.; and
- fish health services provided by Atlantic Fish Health Inc.

2.8 CO-OPERATIVE AND PUBLIC R&D

The available co-operative and public R&D is extensive. Moreover, while it has numerous elements that relate directly to food processing and are meant to facilitate linkages within the cluster, the R&D base does not stop there; indirect but usefully related elements also exist that can justifiably be included as relevant to the cluster. The directly- and indirectly-supportive R&D includes:

2.8.1 Food Research Centre

The Food Research Center is part of the University of Moncton. It specializes in the development of products and technical services for the agri-food industry and of marine products.

2.8.2 Atlantic Food and Horticulture Research Centre

Developing new cultivars and technologies for producing, adapting and protecting horticultural crops, including innovations of their storage, handling and processing, is the mandate of the Atlantic Food and Horticulture Research Centre (AFHRC). Research is also carried out on the nutrition and physiology of poultry meat stock.

The Centre is unique in that it can address problems throughout the entire horticultural food system. Field and laboratory facilities, including postharvest an pilot plant capabilities, permit multidisciplinary research anywhere from the field to the consumer. In addition, its scientific researchers have access to an outstanding library, computing an statistical support, as well as an Industry Relations Officer who assists with outside contracts and funding.

The Centre has facilities at Kentville, Nova Scotia, and at the Senator Hervé J. Michaud Research Farm near Bouctouche, New Brunswick.

Stakeholder alliances particularly with commodity groups, are central to much of AFHRC's research. The matching investment initiative will continue to expand these alliances. The Centre's Industry Relations Officer facilitates and enhances this collaboration. Working with regional advisory committees ensures close interaction with the agri-food industry as AFHRC seeks further alliance opportunities.

A staff of 85, including 25 scientists, work in teams in the following areas:

- Sustainable production and quality of lowbush blueberries;
- Production and distribution of high quality strawberries;
- Production and quality of underutilized berry crops in Eastern Canada;
- Horticultural technology of integrated tree fruit production (IFP);
- Integrated pest management technology for integrated tree fruit production;
- Modern management techniques for field grown vegetable crops;
- Postharvest technologies to add value to fresh fruits and vegetables;
- Technologies to enhance the shelf-life, safety and sensory properties of value-added foods;
- Innovation and evaluation of technologies in food processing distribution and retailing for the benefit of the value-added agri-food industry; and
- Nutrition and physiology of poultry meat stock.

2.8.3 Centre for Animal and Plant Health

The Centre for Animal and plant Health in Charlottetown, PEI, better known as CAP H, is the only facility in the Atlantic region under the umbrella of the Food Production and Inspection Branch of Agriculture and Agri-Food Canada with a technology development mandate. CAP H is located adjacent to the University of Prince Edward Island which includes the Atlantic Veterinary College.

There are two Centres of expertise under the CAP H Banner – one is for Regulated Potato Diseases, the other for Retroviruses of Animals. These Centres are responsible for accrediting private testing laboratories, serving as the reference laboratory, and providing diagnostic services in the respective disciplines. In addition, scientists at the Centre provide expert advice to the national inspection and certification programs and carry out research, technology development, and disease surveys.
Facilities and activities include:

- Level 3 Containment – Provides a safe environment to work with pathogens that a hazardous to humans, agriculture, or the environment;
- Greenhouse and growth chambers – Used to test for non-indigenous and quarantine pathogens to support the potato post-entry quarantine program;
- Animal care rooms – Holding rooms for both large and small animals for technology development and diagnostic purposes;
- Histology laboratory – Modern state-of-the-art facility for preparing thin sections of animal pathology diagnostics and technology development;
- Image capture system – An integrated system for capturing both microscopic and macroscopic images in digital format, providing image analysis functions, and publication-ready output;
- Serological assays – Facilities and expertise for conducting enzyme-linked immunosorbent assays (ELSIA), immunofluorescence, and immunodiffusion tests for bacterial and viral pathogens under a quality assurance program;
- Monoclonal antibody production – For development of highly specific and reproducible indexing tests;
- Molecular biology – Application of DNA probe technology, polymerase chain reaction (PCR), and in situ hybridization; and
- Plant tissue culture – Expertise in generating pathogen-free potato plantlets through heat therapy, meristem culture, and micropropagation.

2.8.4 Charlottetown Research Centre

Located in a province internationally famous for its potatoes, Agriculture and Agri-Food Canada's Charlottetown Research Centre has been involved for over 80 years in the development of productive, profitable and sustainable potato production and field crops.

The Charlottetown Research Centre specializes in techniques to boost yields and drop production costs for potatoes and their rotation corps, including more environmentally friendly methods to control pests and disease and maintain soil quality.

Through the Matching Investment Initiative (MII), a federal fund that allows the private sector to invest in research tailored to its needs, the Centre can negotiate research projects that directly benefit individuals, companies and organizations.

- Staff complement – a full-time staff of 79, including 19 scientists;
- Location – in the hub of Prince Edward Island's agriculture and food research community, including Agriculture and Agri-Food Canada's Centre for Animal and Plant Health, the University of Prince Edward Island, the Atlantic Veterinary College and the Food Technology Centre;
- Fully equipped field research facility at Harrington Research Farm and two other sites in Charlottetown; and
- Research laboratory with green-house and growth chamber facilities.

2.8.5 Potato Research Centre

Established in 1912, the Agriculture and Agri-Food Canada Potato Research Centre is situated on a 300-hectare site overlooking the city of Fredericton and the Saint John River. Affiliated with the centre is a 350-hectare potato breeding substation at Benton Ridge, NB, and a beef research facility at the Nappan Research Farm, near the New Brunswick-Nova Scotia border.

Over the years, the Potato Research Centre has played a key role in the development of the major potato producing areas of New Brunswick and Prince Edward Island. Today, this focus is enlarged with a national Potato Breeding Program and comprehensive research programs in Potato Pest Management and Soils and Engineering.

The Centre works closely with area universities and researchers in other countries, including the International Potato Centre in Peru.

- Total full-time staff of 100 including 20 scientists;
- Land base at three locations, covering 900 ha;
- Extensive greenhouse, growth cabinet and laboratory facilities;
- Co-located with the New Brunswick Department of Agriculture and Rural Development and two additional branches of Agriculture and Agri-Food Canada, the Food Production and Inspection Branch and the Market and Industry Services branch;
- The Nappan Research Farm shares its facilities with the Cumberland County office of the Nova Scotia department of Agriculture and Marketing and the Maritime Beef and Swine Centres; and
- Current research initiatives include: potato genetics, breeding and variety development; potato disease detection; control measures for potato insects; water quality and erosion research; potato harvesting technology; innovative beef production systems.

2.8.6 Gulf Fisheries Centre

With a science program directed toward applied research in the shellfish, groundfish, pelagic, diadromous and molluscan fisheries, the Gulf Fisheries Centre serves the fishing industries of the southern Gulf of St. Lawrence. Administered by the federal Department of Fishers and Oceans (DFO), Maritime Region, the Centre is an integrated management and research site.

Research encompasses:

- Diagromous Fisheries – Research focuses on the biology and habitat requirements of diagromous fishes;
- Invertebrate Fisheries – Lobster and snow crab fisheries in the southern Gulf are the most valuable fishers in Atlantic Canada. Sea urchin, rock crab and toad crab are rapidly developing fisheries. The Centre focuses on measuring the distribution, abundance, biological characteristics and fleet dynamics of these fisheries;
- Marine Fisheries – Determining the abundance, size and age structure, biological characteristics and fisheries dynamics of marine fish stock sin the southern Gulf of St. Lawrence are the main goals of the Marine Fish division;
- Fish Habitat – With the focus on assessment and protection of fish habitat, the Centre's key involvement is through the development of inventory and mapping

expertise and establishing networks with local communities. Integrated coastal zone management, public awareness and education are lead initiatives; and

- Marine Environmental Science – Coordinating scientific advice regarding environmental assessments of major new activities is the thrust of this division.

2.8.7 University of Prince Edward Island

A wide range of state-of-the-art research facilities has enabled The University of Prince Edward Island (UPEI) to attract significant trade and research activity to the province (over $2 million in the past year).
Research includes:

- The K.C. Irving Chemistry Centre, a state-of-the-art, $5.4 million facility, features undergraduate laboratories with modern instrumentation rooms in the teaching wing, plus a research wing with sophisticated labels and support services;

- Atlantic Fish Health Inc. (AFHI) is a for-profit corporation owned by UPEI. It markets its research services to pharmaceutical and biological companies, aquaculture and other fish-related industries, and to institutions;

- The Animal Productivity Health Information Network (APHIN) is a computer-based information network currently serving the dairy and swine industries. It provides an information services to producers and veterinarians along with the infrastructure to support clinical trials of biologics and therapeutics on dairy and hog farms;

- The recently established Lobster Health Research Centre is concerned with the post-harvest disease in the lobster fishery and works in cooperation with government and the lobster industry to investigate, treat and prevent diseases in lobsters;

- The university's Fish Health facilities enjoy an international reputation for excellence in fish health research and services. UPEI has the capability to handle project involving fin fish and shellfish in fresh water and marine environments, at a wide range of temperatures; and

- With its new facilities and a full complement of established research scientists, the Faculty of Science engages in research partnerships with industry and government.

2.8.8 Food Technology Centre

This new facility on PEI provides innovation, applied research and development, technical support and technical partnerships for the food industry. Although it has supported potato processing, current direction even extend to oriental Dim Sum cooking research.

2.8.9 University of Moncton

Research Centre on Energy Conversion – also part of the University of Moncton, the Research Centre for Energy Conversion develops efficient energy systems with a positive environmental impact.

2.8.10 Other Research

A few examples of other food-related research in the cluster are:

- food technology joint instruction and research, provided by PEI's Holland College Food Technology Program;
- environmental conservation, for example, the wetlands dedicated environmental conservation area near Sackville, NB, for research on birds;
- fire safety through the Fire Science Centre at UNB;
- water and particularly ground water - vital to agricultural production - through UNB's Ground-water Studies Group; and
- aerial spraying directly relevant to agriculture through the experimentation of the Spray Technology Group, also at UNB.

2.9 RELATED BUSINESS SUPPORT

The infrastructure and networks provided in PEI/New Brunswick for business development is very extensive. Only a few illustrations are given here. They include:

- an Industrial Outreach Office at UNB, particularly encouraging for the cluster in light of the related research to food processing at the University;
- electronic data interchange (EDI) provided through the cluster's advanced digital telecom and Information Highway links;
- Test facilities provided through the Research and Productivity Council of New Brunswick;
- dedicated science parks such as PEI's Food Pack, home to the Food Research Center and Food Technology Center as well as private firms; and
- available finance and venture capital, such as that provided by ACF Equity Atlantic.

2.10 RELATED PUBLIC SUPPORT

- federal government support available through ACOA. This support involves both region-specific intelligence and research as well as selective financial aid;
- federal government technical support through NRC/IRAP;
- business linkages available through Industry Canada's "Strategis" intelligence and capabilities service;
- technical data, such as that supplied by NRC's CISTI;
- provincial government support for example, through the Economic Development and Tourism Department of New Brunswick; and
- municipal support such as the Greater Fredericton Economic Development Corp.

2.11 COSTS

Costs are a factor. In the past transportation costs have worked against food processors in the region. It was cheaper for agricultural products to be exported directly, processing being carried out nearer larger markets in central Canada. This is still true to a considerable extent today. However, this may show a changing trend in the future. In particular, improved transportation links in the region, particularly in respect of rail networks connecting to the proposed expanded Port of Halifax, and providing a high-volume direct link to large markets in central Canada and even mid-west US, may help to re-dress the cost balances in favour of regional processing. As well, there may be opportunities to set up increased numbers of "premium" packaged food lines that can justify relatively long-distance transport, thanks to increased R&D and innovation within the cluster. Lastly, there may also be positive opportunities to alleviate cost problems by attracting more "head office" functions in food processing firms, to the region.

3.0
CLUSTER DYNAMICS

3.1 MARKETS

The industry, led by a few large firms (e.g. McCain's, Cavendish) has been oriented towards markets outside Atlantic Canada. Smaller firms tend to be more reliant on the regional market.

Distribution and market exposure (by a large chain like Sobeys or IGA) are critical to food processing, especially to smaller firms.

3.2 LOCAL/REGIONAL LINKAGES

The large firms tend to be vertically integrated and, as such, do not link closely to local/regional supplier and support structure. Although food processors source raw materials locally, to a large extent, their linkages are with retailers and distributors, not with other food processors.

Smaller firms interact more closely with the technical infrastructure, particularly to public R&D. For example, 75% of the work done by the Food Technology Centre (PEI) is for firms in the Atlantic region. Smaller firms are niche oriented and are more likely to rely on public research agencies.

However, not many firms feel the need to get technical support. There is a lack of awareness of the technological advances in the sector. A Food Park which provides common facilities for processors (e.g. storage, refrigeration) on shared cost basis has been built in PEI. There have been few tenants to date.

Federal government research institutes are specialized in each province and have a long tradition of working with local industry. Provincial government agencies do likewise.

Vertical integration appears to be a phenomenon not only for large firms (McCain's, Cavendish) but also be medium firms as well (e.g. Ben's Bakery, with 100 employees has its own trucking company).

3.3 EXTERNAL LINKAGES

While the agricultural produces are mainly local, most food processing equipment comes from outside Canada, usually from the U.S.A. Some raw materials are sometimes sourced from outside the region if they can be obtained more cheaply.

The larger firms have a well established presence in markets outside Canada. Smaller firms have more difficulty in the international marketplace and may be satisfied with the local/regional market. Some government funded agencies also have external linkages. The Food Technology Centre of PEI gets 25% of its work outside Canada.

3.4 INFRASTRUCTURE

3.4.1 Technical Support

There are difficulties in obtaining specialized engineering and technical skills, such as plant production expertise.

Also, business management skills training relevant to small operators is lacking.

Government (federal and provincial) has had a long history of supporting agricultural development through its R&D and extension programs. This R&D is of particular importance to smaller firms. The larger players tend to do all their R&D in-house since secrecy is essential.

Potatoes are a specialty of the food processing industry in the region. Agriculture Canada undertakes potato "breeding" R&D. The provincial governments undertake cooperative R&D with farmers. The NB Research and Productivity Council focussed on food processing R&D.

3.4.2 Business Support

Capital is not an issue for the larger firms; most is financed in-house or through the usual debt instruments (banks).

Smaller firms, especially new entrants and those wishing to export, need marketing as well as financial support. They need business advice on managing existing and new operations more effectively.

3.5 SUMMING UP

This sector is driven by a few large vertically-integrated firms. These firms are self-contained and do not interact closely with other firms and institutions in the clusters.
Smaller firms, while they do not cooperate closely with each other, do interact closely with the publicly funded infrastructure, especially for R&D and technical support.

Export markets are dominated by the larger firms, regional markets are not.

4.0
ISSUES IN CLUSTER DEVELOPMENT

4.1 OVERALL CLUSTER STRATEGY

The Prince Edward Island and New Brunswick food processing cluster has a total supply chain capability ranging from agricultural bulk commodities and produce, through intermediate processing into bulk and specialty food products, to multi-line brand name packaged goods marketed and available across Canada and North America. This chain includes virtually all the vital commercial functions required to deliver final packaged goods to market. Capabilities in this value-added chain include farming, transportation, distribution, mass production, successful marketing (both bulk and specialized), brand name recognition, R&D, and managerial cost/effectiveness.

This value-added chain is based on agricultural produce and inputs within the region – potatoes, milk, and certain seafoods such as lobster, oysters, mussels and some fish species.

There has been a deliberate effort by governments to provide supporting infrastructure.

Costs within Atlantic Canada (for example wages and salaries) are not usually a vital limiting factor in determining competitiveness of industry. However, transportation and distribution costs to access major markets in central Canada, the mid-west U.S. and elsewhere, can certainly be a limiting factor. Often such a cost structure favours export from any region of raw materials and resources rather than finished goods, basic economics suggesting that it is better to do processing and packaging close to eventual markets. For PEI/New Brunswick this can mean exporting potatoes rather then packaged french fries. If the value-added is done locally then the product typically needs to be a “premium” one commanding a high price so as to justify the transportation expense.

While these cost implications need to be kept in mind, and undeniably do provide a background to cluster development that cannot readily be modified, nevertheless, considerable innovation opportunities still exist. Some local processing can be done for the regional market itself, and/or the processing value-added can be exploited through investment in production facilities near to the major markets, with high-value “head office” functions such as R&D and central marketing, retained at home.

4.2 ISSUES

Among the issues worth investigating is the impact of scale economies on the PEI/New Brunswick food processing cluster. There are two separate elements in this. First, given existing product lines, are scale economies adequate in the cluster; second, for any new product lines (e.g., diversification), are there going to be barriers to entry to markets from scale considerations? In particular, if a more diversified agricultural base was used as a basis for a broader product line, would there be a necessity for increased use of flexible manufacturing systems (FMS)? The latter typically have actually higher capital costs than traditional lines, making them sensitive to total throughput operations.

The growth opportunities from an innovation standpoint are linked to developing greater scale and diversity from the industrial structure in place. Although this cluster has an excellent continuity from inputs through to multi-line Name Brand packaged food products, certain issues are apparent in developing this cluster further. They include:

- value-added from the agricultural product base: this will have to take into account the relative economics of different farm commodities, possible candidates might include hog- and chicken-based food chains, capitalizing on existing farm surpluses and even waste commodities;
- linkages to the emerging aquaculture capabilities in Atlantic Canada;
- developing a specialized machinery and equipment capability in support of high-output food processing, particularly flexible manufacturing systems applied to the PEI/New Brunswick product lines;
- developing a regional capability to systematically acquire, store and disseminate novel food processing techniques and ingredient combinations (literally food recipes) so as to enhance the cluster's ability to respond to global markets;
- bridging the training gap and the availability of skilled people;
- providing business training including marketing; and
- providing financing to smaller firms; and
- irrigation systems to ensure consistent quality of crop.

4.3 POTENTIAL PROJECTS

Taking overall concurrence with need for diversification approach, and desirability of adding value, in particular, packaged means involving several different, balanced, foodstuffs, then some projects could be:

- developing promotional material for vegetables. A more diversified marketing base, capitalizing on vegetables which are already of fairly wide variety in NB/PEI, would encourage more crop diversity and could use the region's positive "green" environmental image;
- promoting "wildbush" blueberry exports, apples, and other fruits. Another approach to a more diversified crop base would be further development of distinctive brand images, paralleling Oxford Farm's (NS) use of "rhubarb" for pie-filling, and other, similar, initiatives;
- support for market research and export clubs, e.g. in Europe (Germany). It would be useful if export marketing support were available for "out of region" market development. It would be useful for producers in the region to see at first hand how fruit, vegetables and meals were sold and prepared in reachable export countries;
- more efficient uses of pesticides and machinery. Further machinery projects could be undertaken, paralleling the on-tractor computerized soil analysis system, which uses real-time imaging, chemical analysis, etc., to allow optimum fertilizer application;
- use of computers in the cluster/industry for information transfer;
- developing an internship program, e.g., staff from a research center spend 4 to 6 months inside a project developing firms; also co-op program or apprenticeships;
- Agri-food Council could be a "champion", and potential integrator on marketing side;
- promotion of ISO 9000 approach for safety standards;
- "meal solutions" packaged meals; and
- investigation of cost structure e.g. HST, safety standards, etc.